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BRADEN STEEL BUILDING

the OIL AND GAS JOURNAL

Trends

Crude-Oil Production
By States—Page 321

CRUDE-OIL STOCKS 234,667,000 bbl. as of April 1—down 1,618,000. One year ago 239,864,000 bbl.

GASOLINE STOCKS 89,162,000 bbl. as of April 1—up 1,875,000. One year ago 93,840,000 bbl.

RESIDUAL FUEL-OIL STOCKS 51,326,000 bbl. as of April 1—down 343,000. One year ago 67,552,000.

GAS OIL AND DISTILLATE STOCKS 30,530,000 as of April 1—down 789,000. One year ago 31,015,000.

CRUDE-OIL PRODUCTION 4,418,510 bbl. daily average week ended April 8—up 41,060 bbl. Year ago 3,933,810.

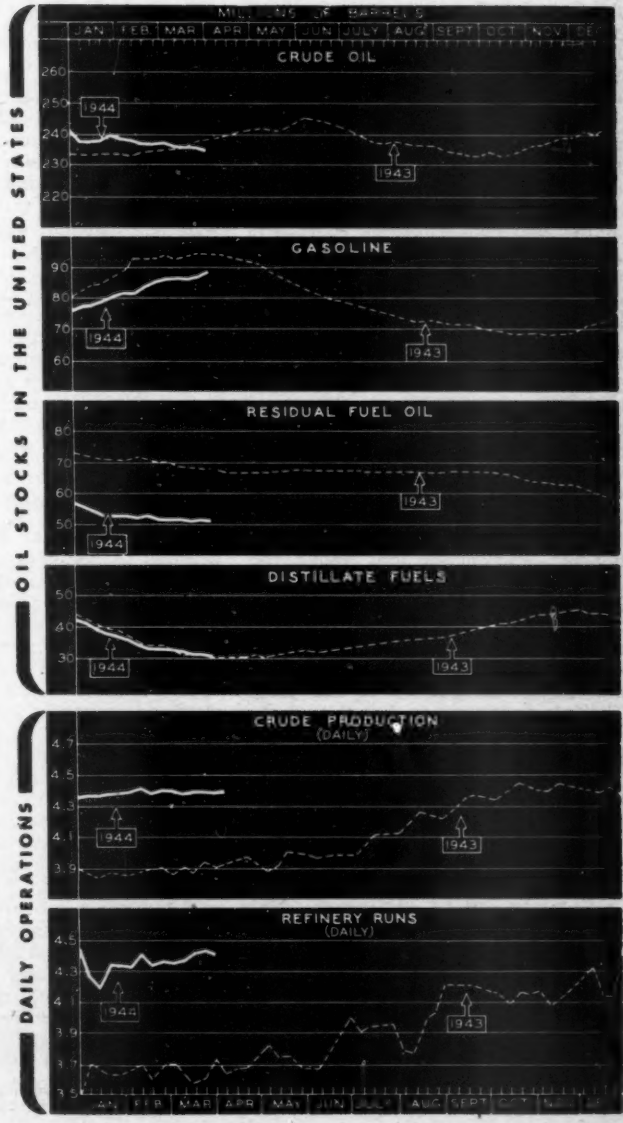
REFINERY RUNS 4,435,000 bbl. daily week ended April 1—down 8,000 bbl.

March 25 stock figures revised.

IN the East an analysis coming from sources within the industry showed that the gasoline situation in that area, from the standpoint of inventories, current production and transportation, was much better on April 1 than on the same date last year. The conclusion was reached that with the improved transportation situation and enlarged output there was no longer any necessity of maintaining a 2-gal.-per-week restriction for the A ration cards. Accuracy of the conclusions of this survey was promptly denied at Washington with a statement by Petroleum Administrator Ickes that lower, rather than expanded, rations were in prospect for civilians.

THERE are economists in the industry however, who continue to insist that information made available by Washington agencies in connection with the rationing restrictions is not convincing. In these analyses it is conceded that only minor increases in domestic crude-oil supplies over the immediate future are in prospect. It is assumed, however, that domestic supplies can be supplemented with additional imports from Latin-American sources, so that further increases in crude runs to stills at domestic refineries can be expected during the second quarter. In this connection representatives of the Government who insist there will be less gasoline for civilians, despite enlarged crude runs to stills, cite examples of smaller yields. There are several plants which have recently installed or are now completing the construction of catalytic cracking and alkylation units to increase the production of 100-octane gasoline. There are instances among these plants in which the new operations result in a substantial decline in the production of the civilian-grade gasoline. Just how important this situation will be in the over-all yields of gasoline has not been made clear.

THE data on plant yields do indicate that gasoline output can be substantially increased provided the required processing equipment is available and also assuming that the yields of some of the other products can be reduced and still leave adequate supplies. The gasoline yield of straightrun and cracked gasolines in January, according to the latest report of the Bureau of Mines, totaled 38.6 per cent, a 2.1 per cent increase over the same month last year. The distillate yield in January was 14.5 per cent and residual fuel oil 28.9 per cent. The yields of gasoline are low and those of fuel oil are high when compared to yields previous to Pearl Harbor.



Rotary Drilling Operations Rise But Make Less Footage

WASHINGTON.—There are 1,400 rotary drilling rigs at work in this country, compared with 713 that were in operation January 1, 1943. The number rose to 900 during June, to 1,160 by October 1, and then continued its steady climb. Indications are that during the third quarter the number of active rotary rigs will reach 1,500. These operations are approximately 40 per cent less efficient than they were in 1940 and 1941, and fewer feet of hole per unit of time are being drilled than during normal years. This trend heightens the need for drilling machinery and decreases the relative use of oil-producing equipment.

Definite improvement in many of the previously tight spots in the petroleum-industry equipment situation is reported in this account. Easier items include new drilling engines and maintenance parts for approximately 70,000 that are already in service. The outlook is that no drilling operation will be delayed or deferred for the lack of equipment during remainder of the year. The number of rotary rigs in service is expected to rise to 1,500 by third quarter, an all-time high.

The foregoing facts are included in a report on materials required for oil-industry production operations prepared by Frank A. Watts and presented by Claude P. Parsons, director of the Materials Division, Petroleum Administration for War, before Petroleum Industry War Council Production Committee, meeting in Washington last week.

PAW's allotment of carbon and alloy steel in the second quarter of 1944 was 558,520 tons, compared with 520,800 tons allotted for the first quarter. The latter figure, however, includes 1,580 tons allocated to the 20-in. products line which is a nonrecurring item. Second quarter allocations of alloy steel total 93,520 tons, an increase of 4,720 tons over the first quarter, and 50,549 tons above the quota for the third quarter in 1943.

"It is planned," says the report, "that 262,000 tons of carbon and alloy steel casing, tubing, and drill pipe will be produced and delivered during the second quarter of this year. There is no indication that the supply of oil-country tubular goods will not be sufficient for the uninterrupted conduct of domestic drilling operations, even though the rate may continue to accelerate.

"Drill pipe is now being produced at a rate slightly in excess of net requirements. There is no known reason why it will be necessary to delay any drilling operation for lack of drill pipe, provided operators make plans reasonably well into the future. The present backlog of orders for tool joints is 220,000. The supply is being gradually increased, and cooperation of the production operators and tool-joint manufacturers will continue to prevent any serious delays in drilling operations. Tool joints are now being manufactured and delivered at a rate which slightly exceeds the rate at which they are being worn out.

"Unless some unforeseen military program develops, allotments to PAW will be sufficient during the second and third quarters of 1944 to enable all operators to acquire all tubular material needed for their drilling program. The elimination of Form PAW-35 makes it particularly important that as many production operators as possible prepare and file purchase orders for oil-country tubular goods as much as 3 to 3½ months in advance of the quarter in which the material is to be delivered for use.

Engines Still Scarce

"There continues to be a greater demand than supply of new internal-combustion engines and parts for old engines. However, engine parts are beginning to move to oil-field engine distributors at a steadily increasing rate. Unless there is some unpredictable interference, the day is not far distant when parts for the petroleum industry's 70,000 or more internal-combustion engines will begin to move into the hands of the established oil-field distributors at rates equal to actual requirements.

"Petroleum operators must insist that those engine distributors from whom they normally obtained their engine parts acquire and maintain a minimum, yet adequate and balanced, stock of engine parts. As soon as the distributors acquire and maintain stocks of parts, petroleum operators should obtain their repair parts from the established distributors. However, they should not obtain parts from the distributors' stocks to be carried as idle inventory by themselves.

"It now appears that sufficient new engines will be delivered during 1944 to prevent any serious disruptions in petroleum operations. Here again, the engine distributors and manufacturers must carry the ball. On them, petroleum operators must depend for engines actually required for petroleum operations.

"The item now giving the petroleum operators most concern is trucks, particularly heavy-duty types. There are several reasons. Petroleum operations have been steadily increased. This condition has promoted the need for trucks, while at the same time the limited number of trucks available to petroleum operators have been rapidly wearing out on account of age and extremely hard service. In addition, repair parts have not been availabe for the maintenance of trucks in service.

"PAW is now conducting a survey to determine:

"1. The number of trucks primarily engaged in and required for petroleum and associated operations, other than transport and marketing operations hauling petroleum products either in bulk or in containers. The Office of Defense Transportation has already compiled and made available sufficient information on trucks engaged in transport and marketing operations.

"2. The number of trucks (if any) owned by petroleum or associated operators which are stored, but usable, and could be promptly conditioned and placed in service.

"3. The absolute minimum number of trucks which must be acquired by July 1 to prevent serious disruptions in petroleum operations—refining, natural gasoline, transportation (other than transport or marketing), or production (including related services).

"4. The minimum total number of trucks which must be acquired during the remainder of 1944 to prevent serious disruptions or delays in petroleum operations."

Problem of Deferring Key Men Undecided

WASHINGTON.—No formal program for the draft deferment of key men in the petroleum industry has yet been adopted by the interdepartmental committee which has been working on the occupational deferment problem for the past 2 weeks.

The Petroleum Administration for War has been authorized to endorse special requests for deferment of key men under 26 years of age holding technical positions in 100-octane production, and it probably will be given similar authority as to other branches of the industry but as yet there has been no decision as to the number of such men to be deferred, the occu-

pations where deferment is possible, or the exact procedure to be followed.

Selective Service is making a determined drive to draft virtually all physically fit men under 26, and all occupational deferments in this age group are being reviewed by local draft boards. Continued deferments in this group will be confined to a limited list of industries with the highest rating of urgency in the war program and to individual technically trained men whose work is vital to immediate war production and who cannot be replaced from any source. Such deferments will be made only on certification by PAW or other federal agencies, and this will require plant personnel managers to give complete details about each individual for whom deferment is requested, the nature of his work, its importance in war production, and the difficulty of replacement.

PAW officials, together with representatives of a dozen other war agencies, have been meeting in an interdepartmental committee almost continuously for the past 2 weeks in an attempt to determine the numbers and categories of technical men under 26 in each war industry who may be granted continued deferment, and the program is expected to be completed shortly. At the same time new procedure may be worked out to make occupational deferments somewhat easier for men older than 26 in essential industries.

Senate Committee Names Counsel, Prepares to Open Oil Hearings

WASHINGTON.—The Senate foreign oil policy committee expects to begin open hearings on the Arabian pipe-line proposal of the Petroleum Reserves Corp. and related matters about May 1.

The Senate committee has appointed as counsel Richard Joyce Smith, of Southport, Conn. For the past 10 years Smith has been a member of a large New York law firm. He formerly was on the faculty of Yale University law school. He is a member of Connecticut Public Utilities Commission; chairman of American Bar Association, public utilities section, and served as campaign manager for Sen. Francis Maloney, chairman of the special committee. Smith will assume his post as soon as he can wind up personal affairs.

The State Department announced United States technical experts to begin discussions with British next week: Charles B. Rayner, Paul Alling and Leroy Stienbower of State Department; Ralph K. Davies, and C. S. Snodgrass of PAW; Brig. Gen. Howard Peckham of the War Department, and Commodore A. F. Carter of Navy. Rayner is Chairman Davies' vice chairman.

Ralph K. Davies, deputy petroleum administrator, will represent PAW in discussions with British oil delegation

Charles B. Rayner, petroleum adviser to the Department of State, who will serve as chairman of the American commission

Secretary of the Interior Ickes, in his capacity as president of PRC, appeared before the committee in executive session last week to explain the proposal, and was followed by Charles B. Rayner, petroleum expert of the State Department. PRC is still attempting to negotiate a contract for pipe-line construction with the three interested American oil companies in spite of the fact that some members of the Senate committee have expressed the view that negotiations should be suspended during the investigation.

The State Department expects to commence discussions shortly with a British delegation concerning postwar world petroleum matters, and these conferences are expected to proceed independently of the Senate study. The conferences will be in two parts—on the top policy level and on the expert technical level. The membership of the British technical delegation has already been announced.

Subsidy Plan Handed PAW for Recommendation

WASHINGTON.—The subsidized price increase plan for crude petroleum from stripper wells has been referred to the Petroleum Administration for War by the Office of Economic Stabilization, and no action is expected until PAW reports.

PAW Administrator Ickes, Deputy Davies, and Production Director Knowlton were called into conference on the plan with OES Director Fred M. Vinson last week, and PAW is currently drafting its comments. On several occasions during the past year or more PAW officials have voiced their unanimous objection to any subsidy proposal as an alternative to a general crude price increase, but OES is not expected to be greatly influenced by the views of the administration's official oil agency.

Gulf to Present Service Awards to 4,448 Employes

PITTSBURGH.—President J. Frank Drake last week announced that 4,448 men and women of the Gulf Oil Corp. and its subsidiaries will be given service awards for having completed 10 or more years of service in the company, at the same time paying tribute to the contribution of all employes to the war effort.

Of the 4,448 employes in Gulf offices in 30 states to receive jeweled emblems and certificates, 1,960 have completed 10 years; 1,052, 15 years; 915, 20 years; 389, 25 years; 89, 30 years; 30, 35 years and 13 have rounded out 40 years with the company. This marks the fifth annual distribution of awards and altogether 14,884 Gulf employes with 10 or more years of service have been honored.

PIWC Fights Black Market In Gasoline Coupons

by Henry D. Ralph

WASHINGTON. — Appointment of an 11-man committee to conduct a campaign against the black market in gasoline ration coupons was the chief accomplishment of the Petroleum Industry War Council at its monthly meeting April 5 and 6.

The committee will be composed of the chairmen of PIWC's five district committees on marketing, the chairmen of the five district subcommittees of PIWC's committee on products conservation, and B. I. Graves, chairman of PIWC's committee on products conservation. B. L. Majewski, chairman of the PIWC committee on marketing, was named chairman of the new committee, established as a subcommittee of the committee on products conservation.

Much discussion developed over the long-standing grievance of Texas producers against the well-spacing and drilling restrictions of PAO-11, and a resolution was proposed asking the Petroleum Administration for War to return spacing control to states with adequate regulatory agencies. However, no action was taken and a committee of Texas producers was delegated to discuss the matter further with PAW officials. Since PAW is on record as insisting that federal control of drilling must be retained as long as materials are allocated by the federal government, the general expectation is that no sweeping modification of PAO-11 will be made in the immediate future.

Knox and Patterson Speak

Secretary of Navy Frank Knox and Undersecretary of War Robert Patterson were guests of the council, and both praised the oil industry for its successful prosecution of the 100-octane aviation gasoline program. Secretary Knox invited questions and was asked particularly about the Arabian pipe-line project of the Petroleum Reserves Corp. While saying he was not wedded to the details of the project as now pending, Knox insisted that immediate construction of a pipe line and a refinery on the Mediterranean is necessary for prosecution of the war and he strongly advocated government participation in foreign oil development as the best assurance of protecting American oil interests against expropriation or unfair competitive actions by other governments.

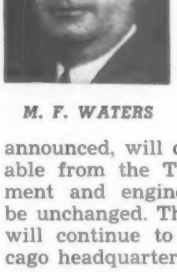
In lieu of its usual monthly report the committee on petroleum economics submitted a brochure containing 17 charts and tables giving statistical trends in the petroleum industry from 1918 to 1944. The booklet is intended as source material for the industry, government agencies, and congressional committees in discussions of drilling, production, demand, exports and prices.

The council adopted a statement by its economics committee supporting the position of PAW that the demand and supply position of the industry does not warrant any relaxation of civilian gasoline rationing.

Appointment of a committee to head up the fight against the black market followed the appearance before the council of officials of the rationing division of the Office of Price Administration who pointed out the serious effects on gasoline distribution which might result if black-market operations continue to grow. They declared there is ample evidence that gasoline retailing is falling into the hands of criminals and professional racketeers who are making "big business" of dealing in counterfeit and illegally endorsed ration coupons.

The production committee of the council devoted most of its session to a discussion of the Texas proposal to revoke PAO-11 or to return drilling control to states with regulatory agencies, but nothing definite was accomplished. Donald R. Knowlton, PAW production director, defended the status quo, chiefly on the ground that drilling control is inevitably tied in with wartime control over distribution and use of steel and other materials. He presented statements he and Deputy Administrator R. K. Davies had made to the Interstate Oil Compact Commission on the same subject and promised that PAO-11 would be relaxed as rapidly as conditions warrant and that modifications may be expected soon for drilling in several areas, particularly Illinois, the Texas Panhandle and North Texas.

Hanlon-Waters Improves Position for Postwar Era



M. F. WATERS

A step was taken last week to strengthen the postwar position of Hanlon-Waters, Inc., Tulsa, which was acquired by The McAlear Manufacturing Co. of Chicago. Hanlon-Waters oil-field products, M. F. Waters, president, announced, will continue to be available from the Tulsa plant. Management and engineering officials will be unchanged. The McAlear company will continue to function from Chicago headquarters.

Customers of each company, Waters said, will benefit from this pooling of patents, designs and engineering experience. The Hanlon-Waters oil-field line of automatic controls, separators, and tanks will be immediately supplemented by such McAlear controls as the combined engineering staffs of the two companies regard to be best for petroleum service.

Similarly, the McAlear line will be complimented by outstanding features in products of Hanlon-Waters products.

Frontier Christens New 100-Octane Fuel Plant

Starting from a small bulk plant and two second-hand trucks back in 1925, Frontier Refining Co. of Cheyenne, Wyo., climaxes its corporate progress this week when it dedicates a new 100-octane aviation fuel plant which has been under construction for a year or more. The plant was built under direction of Defense Plants Corp., and is the last plant authorized by that federal agency under the aviation-fuel program.

The plant includes a fluid catalytic cracking unit, making aviation fuel base stock; an anhydrous hydrofluoric acid alkylation unit producing alkylate for the same purpose, and an isomerization unit using aluminum chloride as catalyst, to prepare additional amounts of isoparaffins for the alkylation process. Olefins required for alkylation are obtained from the light gases both from the catalytic cracker and from the Dubbs cracking and reforming unit which is part of the original refinery, operating before the new aviation-fuel plant was built.

The 100-octane plant has been on stream for some time, ironing out the "kinks" and perfecting operations, and is now turning out aviation fuel at a maximum rate, all of which is sold to the armed forces.

THIS WEEK

FOREIGN—Efforts persist to close up Arabian pipe-line deal. . . . Question arises whether project will wait on Senate public hearings, tentatively scheduled to start May 1. . . . Committee has heard two government officials in executive session. . . . Counsel and clerical personnel remains to be hired before public hearings open. . . . ¶Two-hour discussion of Arabian petroleum affairs develops at Petroleum Industry War Council. . . . Secretary of Navy Knox and Under Secretary of War Patterson appear in support of project, say it is germane to war. . . . Council members silent on details. . . .

DRILLING—PAW predicts number of active rotary rigs will rise to 1,500 in second or third quarter. . . . First quarter results show completions fell 14 per cent behind quota. . . . Downward revision of year's well program to 20,000 or 22,000 completions held probable. . . . ¶Rigs in operation are only 60 per cent as efficient as in peacetime, raising per unit drilling time, requiring more men, materials and other accoutrements. . . .

TRANSPORTATION—Preliminary negotiations started for natural-gas line, from West Texas to Los Angeles. . . . Cost calculated at $50,000,000, probably of RFC funds. . . . ¶More of 20-in. product-line capacity appropriated for shipment of 80-octane gasoline. . . . Both WEP lines continue at capacity operation or higher. . . .

MATERIALS—Shortages of drilling engines being overcome. . . . Burden for adequate distribution placed on manufacturers and supply companies. . . . Consumers urged to project requirements as far as possible, BUT to refrain from ordering in excess of actual needs. . . . ¶Tool joints are being manufactured at higher rate than they are being worn out, yet backlog orders of 220,000 remain impressive. . . . ¶Operators assured supplies will be made available for all authorized wells. . . .

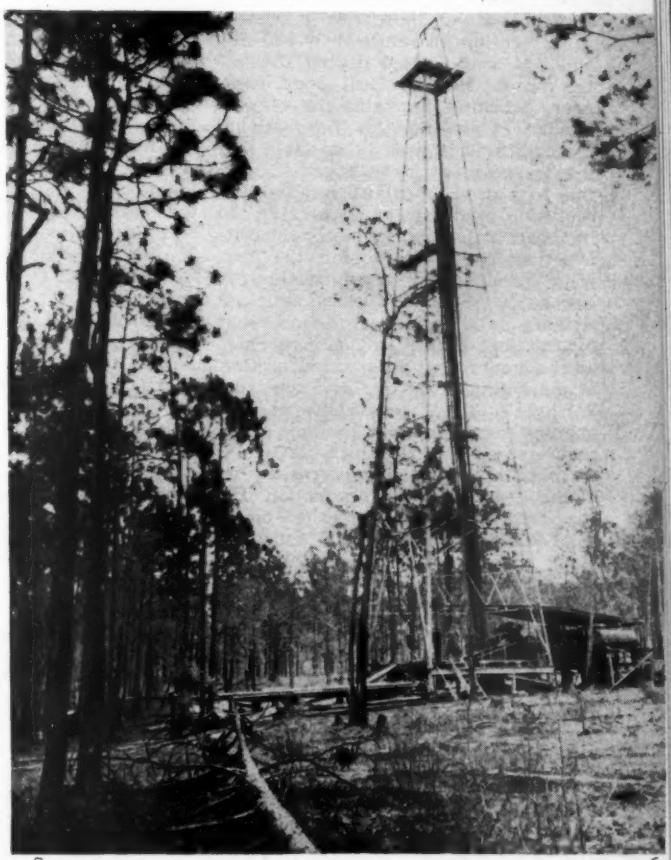
MANPOWER—Interdepartmental discussions continuing in Washington. . . . Framework established for deferring key men in 100-octane program, regardless of age. . . . ¶Negotiations follow line of deferring majority of key men from 26 to 38, assuming most oil-industry jobs are vital. . . .

SUPPLIES—Regulations tightened on liquefied petroleum gas and naphtha. . . . Violations of spirit of regulations by which motorists were burning large quantities of butane rampant in California. . . . PIWC confirms PAW stand that no relaxation in gasoline rations can be justified. . . . Subcommittee organized to make PIWC more active in combating black market. . . .

SPACING—PIWC declines to take action on proposed resolution returning authority over well patterns to states. . . . Action sponsored by Texas members, where most of agitation has outcropped. . . . ¶Amendments under preparation modifying restrictions in Illinois, North Texas, Texas Panhandle. . . . Some North Texas wells may be permitted 5-acre patterns. . . . ¶PAW invites states to establish reasonable development patterns, in cooperation with operators, where the changes are too liberal. . . .

OPINIONS—Journal survey shows 14 to 1 opposition to subsidy. . . . Manpower considered most critical problem. . . . Majority favor return of PAW regulatory powers to the states—on a gradual basis. . . . Most think spacing control could be returned promptly, indicating strong opinions of Texas operators. . . .

PRICES—Moderate advances authorized by OPA in California, Michigan. . . . Fuel markets in Chicago area spelled out, specification coverage narrowed. . . . Economic Director Vinson turns crude-oil subsidy plan over to PAW for study, recommendation. . . . No action anticipated until Administrator Ickes' staff formulates decision. . . .



Symbolic of the accelerated exploration program is this rig in south Georgia. Much wildcat drilling is under way or projected in the so-called southeastern states from Mississippi to Florida

Saving of Steel Is Chief Theme at Corrosion Engineering Conference

by E. H. Short, Jr.

HOUSTON. — Corrosion engineers from all sections of the United States and parts of Canada assembled here this week for the 3-day annual conference of the National Association of Corrosion Engineers. Importance of this meeting during which ideas for the prevention and control of corrosion were discussed and exchanged is reflected in the high priority travel rating assigned to a number of representatives from distant sections of the country. Far exceeding the attendance forecast by local officers, registrations the first day approached the 200 mark.

Many of the members of this new organization were connected with the cathodic section of the Petroleum Industry Electrical Association. In order to embrace all industries interested in corrosion-prevention work the N.A.C.E. was formed during the latter part of 1943 by Gulf Coast engineers working on problems of corrosion. In calling the first annual meeting at this time it was felt that the exchange of ideas, together with the formation of plans for fighting corrosion might prove a valuable aid in the conservation of steel and critical materials needed for the war effort. The extent to which this organization might be of invaluable assistance in this respect is indicated by the fact that K. K. Logan, chief of the underground corrosion section of the National Bureau of Standards, Washington, was on hand at the opening session to bid for any cooperation by N.A.C.E. which might be of aid in combating corrosion in plants geared to war production. He also anticipated the corrosion problems which are expected to arise along the big-inch line to the East Coast.

Papers presented during the 3-day conference covered practically all types of corrosion problems and many members expressed the belief that the meeting would go down as the most complete symposium on corrosion ever held.

One of the most valuable functions of the N.A.C.E. will be the dissemination of corrosion data to all members through an organization publication. Another important aim will be to acquaint those industries which contemplate work of this kind with the vast amount of corrosion-prevention experiments already performed. The organization hopes to save the man hours of time an industry might expend by inadvertently trying methods which have been definitely condemned. Still another function of the N.A.C.E., carried over from the organization when it was a branch of the P.I.E.A., is that of a clearing house to prevent damage of unprotected structures in areas where cathodic protection is in use.

Another important service that the N.A.C.E. expects to render is that of keeping its members informed of the special types of corrosion problems as they arise and also the economic significance of such problems. T. W. McGuire, Cotton Valley operators' committee, presented data pertaining to a serious corrosion problem being experienced in high-pressure gas-condensate fields; and brought out the need for a method of detecting internal corrosion in tubing. Value of the work in disseminating information was illustrated in a paper delivered by T. B. McDonald, United Gas Pipe Line Co., which dealt with proposed methods for doing the work suggested by McGuire.

R. A. Brannon, Humble Pipe Line Co., was reelected president of the N.A.C.E., and O. C. Mudd, Shell Pipe Line Co., was reelected secretary-treasurer. F. J. McElhatton, superintendent of the Panhandle Eastern Pipe Line Co., Kansas City, Mo., was elected to the newly formed office of vice president.

Members of the new board are: Walter F. Rogers, Gulf Oil Corp.; Robert Pope, Bell Laboratories, New York; G. R. Olson, United Gas Pipe Line Co., Shreveport; Lyle R. Sheppard, Interstate Natural Gas Corp., Monroe, La., and Guy Corfield, Southern California Gas Co., Los Angeles.

Diesel Engineers to Hold Third Wartime Meeting

Covering current problems of operation and design as well as recent developments that will influence the internal-combustion engines of the future, the Seventeenth National Oil and Gas Power Conference tentative program just released shows a wide variety of interesting papers. This meeting, the third to be held in wartime, will take place May 8-10 at the Mayo Hotel, Tulsa.

Current problems to be discussed include control for aviation, marine and railroad engines, governing of engine generators in parallel, controls for pipe-line engines, operation of pipe-line stations, aircraft-engine maintenance, and exhaust-system design. Looking to the future, other papers will cover gas-turbine prospects, development in turbocharging, and design progress in gas-diesel engines.

Present plans for inspection trips include a visit to the maintenance shops of one of the large pipe-line companies and possible visits to a bomber assembly plant and an oil refinery.

Other highlights of the meeting will be the All-Engineers luncheon on Monday, May 8, the informal banquet that evening and the All-Engineers meeting on Tuesday evening, May 9, at which a motion picture on airline maintenance will be presented in connection with a talk on the same subject.

The tentative program follows:

Monday, May 8

Session on gas turbines and superchargers, 2 p.m.:

"Present Status and Future Prospects of the Combustion-Gas Turbine"—S. A. Tucker, associate editor, Power, New York.

"Recent Developments in Turbochargers"—C. F. Harms, manager, Supercharger Department, Elliott Co., Jeannette, Pa.

Tuesday, May 9

Session on power plants, 9:30 a.m.:

"Design Progress in Gas-Diesel Engines and Plants"—Robert Cramer, assistant chief engineer, Nordberg Manufacturing Co., Milwaukee, Wis.

"Designing Exhaust Systems for Best Engine Performance"—Ralph L. Leadbetter, Burgess-Manning Co., Chicago.

"Panel Discussion on Operation of Engines in Pipe-Line Service"—led by J. G. Norton, chief mechanical engineer, Magnolia Pipe Line Co., and other leading pipeline engineers.

Session on aircraft-engine maintenance, 8 p.m.:

"Airline Maintenance" (illustrated by a motion picture)—R. A. Miller, superintendent of overhaul, American Airlines, Inc., New York.

Wednesday, May 10

Session on engine control, 9:30 a.m.:

"Control for Aviation, Marine and Railroad Engines"—papers by W. C. Trautman, Bendix Aviation Corp.; M. A. Edwards, General Electric Co., and R. R. Stevens, Westinghouse Air Brake Co.

Session on governing, 2 p.m.:

"Analysis of Frequency Characteristics of Governors, Drives and Engine-Generating Sets"—W. E. Skinner, U. S. Engineers, North Atlantic Division, New York, and P. L. Giering.

"Hydraulic Control Methods for Pipe-Line Engines"—J. R. Polston, engineer, Stanolind Pipe Line Co., Tulsa.

Nineteen New Tankers Put Into Service in March

WASHINGTON. — Nineteen standard tankers were among the 152 ships, totaling 1,538,357 deadweight tons, delivered to the U. S. Maritime Commission during March. The commission received 410 ships, totaling 4,115,951 tons, during the first quarter.

Spacing Regulations to Be Relaxed In Illinois, Panhandle, North Texas

OPERATORS in the Illinois basin may expect an amended spacing regulation order any day permitting 10-acre spacing to all sand pools and 20-acre spacing through the McClosky limestone, D. R. Knowlton, director of production, Petroleum Administration for War, told the Interstate Oil Compact Commission at New Orleans last week.

A supplementary order is also being drafted for North Texas, Knowlton said, which will permit 5-acre spacing down to 1,400 ft., 10-acre spacing to 2,500 ft., and a 20-acre pattern to 3,500 ft., which will in some cases permit closer spacing than the operators and the Texas Railroad Commission may desire. In such cases, PAW officials hope that the operators and the Railroad Commission will establish field rules under the provisions of the state statutes.

For the Texas Panhandle, Knowlton said, a supplementary order will be issued in the near future, permitting 20-acre spacing, with 660-ft. intervals between wells.

The 24,000-well program of PAW for 1944 will probably not be realized and may be reduced to between 20,000 and 22,000, according to Knowlton, not because of lack of tubular goods, but due to shortages of manpower, trucks, engines, bearings, speed-reduction gears, and some other critical items, particularly those which are also required for the landing barges used in invasion by the military forces.

Answering criticisms of PAW's well spacing regulations, Knowlton quoted letter dated March 1, 1944, from Deputy Petroleum Administrator Ralph K. Davies to Col. Ernest O. Thompson, Texas railroad commissioner. Davies' letter outlined several points which made the issuance of well spacing regulations essential and pointed out that materials were subject to the authority of the War Production Board; hence if PAW did not devise some method of rationing materials and manpower among petroleum operators, the WPB or some other federal agency would take over the task in some form or manner.

Davies' points can be summarized as follows:

1. Due to the over-all shortage, first of materials, and later of manpower, rationing systems had to be devised and administered.

2. The need for continued drilling to maintain maximum sustained productive capacity, coupled with the limited amount of materials, made it essential to devise a material rationing plan which would give the maximum sustained productive capacity for the materials and manpower expended.

3. The WPB permitted PAW to establish the system and regulations now in existence, rather than attempt to apply general WPB regulations, on PAW's assurance that it would result in efficient use of materials.

4. The present system differs only in degree from those in operation in most states in peacetime.

5. Unless and until the WPB is able to remove all its controls over materials, not only for oil, but for all other industries, revocation of PAW regulations would only result in each operator having to apply for priorities on each well. Furthermore, such revocation would not leave the industry subject only to state regulations, but would result in some other federal agency stepping in to take over the task.

6. As fast as the materials situation has improved, PAW has issued supplementary orders, relaxing controls to the extent the improved materials situation justified.

Knowlton stated that PAW had only 7 employes, including stenographic help, in Washington devoting their time to the administration of spacing regulations, while there were 80 people devoting most of their time to securing materials and manpower for the industry. He pointed out that 90 per cent of the wells now being drilled came under the automatic provisions of the regulations; 6 out of the 10 per cent exceptions were handled in the field offices; and only 4 per cent of the drilling wells required filing for exceptions in Washington.

Navy Reconnaissance Party Studying Alaska Area at Point Barrow

WASHINGTON.—The Navy Department has sent a reconnaissance party to Point Barrow, Alaska, to begin exploratory work on the 35,000-sq. mile Naval Petroleum Reserve 4 in that area.

Navy spokesmen stressed that the present party will engage purely in reconnaissance work and that no large sum of money will be spent and no extensive development undertaken until a report is obtained from this group. Oil seepages have been found in this area and the U. S. Geological Survey investigated in it 1923 and 1924 and reported that the geology is promising for oil discoveries, but little is actually known of the possible oil resources.

The party may do a small amount of test drilling but its principal assignment is to report on the problems of transportation, housing, provisioning, and general working conditions which will confront geological parties and drilling crews which may be sent there in the summer. An appropriation will be asked of Congress if it is decided to proceed with extensive exploration and development. The Navy is cooperating with the U.S.G.S. and the Petroleum Administration for War in this venture.

The party is under the direction of Lt. William T. Forhan, U.S.N.R., a geology graduate of the University of Washington. In 1922 he worked for the Naval Coal Commission in Alaska, and in 1923 and 1924 made two trips to the Point Barrow area as a geologist with the U.S.G.S. From 1925 to 1936 Forhan was a geologist on the foreign staff of Standard Oil Co. (New Jersey) in Argentina and Bolivia, and was in the Near East in 1941, joining the Navy about a year ago.

Michigan's Gas Production In 1943 Hits New High

LANSING.—Breaking all previous records, Michigan's natural-gas production in 1943 exceeded that of 1942 by almost 2 billion cubic feet. The state's wells yielded 10,581,420,000 cu. ft. of dry natural and casinghead gas, having a heat value equivalent to that of approximately 1 million tons of coal or 4 million barrels of oil.

The gas was valued at $2,841,607 at the well, an average of 14.56 cents per 1,000 cu. ft. Natural-gas production in Michigan has been increasing since 1938, when it was less than 10 billion cubic feet.

Journal's Survey of Current Opinions

OVERWHELMING opposition to any form of subsidy payments by the federal Government to the petroleum industry was voiced in the current Journal survey of opinion. On none of the other three most important petroleum industry problems was the attitude of 369 respondents so crystalized. The tally showed that 339 votes were cast in outright opposition to any form of subsidy payment while 25 operators returned affirmative answers, a ratio of nearly 14 to 1 on the negative side of the issue.

Fourteen of the 25 ballots cast in favor of a crude-oil price subsidy were from Oklahoma and Texas operators. Oklahoma operators, the survey disclosed, were more inclined to favor the subsidy than were those in the typical stripper-well states such as Pennsylvania which returned 100 per cent negative ballots.

Less pronounced but nonetheless significant was a majority of more than 2 to 1 on the affirmative side of the question: "Do you feel that the time has now arrived to start the liquidation of the Petroleum Administration for War?

A qualifying question, however, indicated a temperate attitude among technical and managerial personnel of the industry. While nearly two out of three thought the time had arrived for turning back part of PAW's power, 177 respondents voted for gradual release of federal authority against 96 who voted for abrupt liquidation of the central petroleum authority.

Ninety-three operators accepted the invitation to suggest desirable modifications of PAW regulations and methods for return of that agency's regulatory powers to the state conservation bodies. Most suggestions were for return of well-spacing powers to the states promptly, presumably leaving other authority with PAW. Several want regulatory powers returned only to those states which have adequate conservation laws. Still others qualified their opinions that authority over the industry should be decentralized with such statements as "when supply of materials permits" or "when the war is won." A few operators expressed unqualified support of PAW and asserted that it had served the industry in a thoroughly satisfactory manner.

A majority of the expressions that authority over well spacing and production quotas should be returned to the states came from Texas which is not quite as significant as it may appear on the surface because of the larger number of replies received from that state.

Balloting on the question of what is the most critical problem facing the drilling industry was fairly close between manpower and lack of price incentive. A slight majority of the votes cast for manpower indicates the growing seriousness of the labor shortage and encroachment of military inductions. There were 216 replies mentioning manpower and 194 classified insufficient price among the most critical problems. Answers to this question overlapped considerably with some respondents marking two or more problems, possibly rating their answers as equally important. Where specific ratings were included in the duplicated replies, a majority rated manpower as the No. 1 problem. Lack of materials slumped to third position and dearth of locations was a poor fourth in this part of the survey.

Strong sentiment was voiced in favor of selling the War Emergency Pipelines, Inc.'s two systems from Texas to the East Coast to private owners. Here, too, there were a few overlapping replies because several operators desire that one or both of the big-inch lines after being sold to private owners should be converted to natural-gas transmission service.

This fourth Journal sample of oil industry opinions is predicated on a return of nearly 400 replies to questionnaires mailed to a general cross-section of technical and managerial personnel. Replies represent expressions from independent operators and men associated with semimajor and fully integrated companies. Expressions are freely given because of the provisions that respondents need not disclose their identity and, therefore, represent a reliable cross-section of opinion on major problems currently confronting the industry.

Summary of the Industry's Thinking

1. What is the most critical problem facing the drilling industry in your judgment?

Lack of materials	52
Insufficient price incentive	194
Dearth of good locations	38
Manpower	216
Other	14
No answer	12

2. At the conclusion of the war emergency period, should the two big-inch pipe lines, the 24-in. and the 20-in. be:

Converted to natural-gas transmission lines	96
Sold to private owners and operated as common carriers for crude and products	251
Operated by the Government as common carriers	12
Junked and abandoned	10
No answer	25

3. Are you in favor of any form of subsidy payments to the oil industry by the Government?

Yes—25. No—339. No answer—5.

If so, do you favor the price scale recently suggested as follows: 30 per cent over posted price for wells producing 5 bbl. per day and less; 20 per cent subsidy for 6 bbl. per day; 10 per cent for 7 bbl. per day?

Yes—26. No.—69.

If so, do you favor the footage factor of minimum subsidy to wells drilled 2,500 ft. or less; intermediate subsidy to wells between 2,500 ft. and 4,500 ft. in depth; maximum subsidy to wells 4,500 ft. and deeper?

Yes—21. No—64.

If so, do you favor the inclusion of a factor to take care of wells regardless of depth, which produce a large volume of water, and in which the oil production is only a small percentage of the total fluid produced?

Yes—26. No—65.

4. Do you feel that the time has now arrived to start liquidation of the Petroleum Administration for War?

Yes—253. No—105. No answer—11.

If so, do you think this liquidation should be:

Gradual—177. Abrupt—96.

Completions Lag 14 Per Cent Behind Quota

by Charles J. Deegan

THE Petroleum Administration for War's program of 24,000 wells for 1944 will not be realized unless the conditions that caused the first quarter completions to fall 14 per cent short are remedied. The statement of D. R. Knowlton, PAW director of production, to the Interstate Oil Compact Commission at New Orleans last week, that the goal may have to be revised downward to between 20,000 and 22,000 wells, looks somewhat overoptimistic when the first quarter's results are analyzed.

In Districts 1 and 5 the first quarter shortage was about the same, 10 per cent. In these two districts there are no major transportation problems and there is a crude shortage. The 10 per cent deficit in well completions in these two districts consequently must be due to other conditions. An investigation shows that three reasons are repeatedly listed: (1) lack of manpower, (2) lack of drilling equipment, including trucks in drilling service, and (3) inadequate price for crude; not necessarily in that order of relative importance.

In Districts 3 and 4 the shortage in completions was more than twice as high in percentage as in Districts 1 and 5. These two districts suffer from lack of transportation outlets as the pipe-line facilities under construction or contemplated were not far enough along to aid first-quarter operations. In addition, District 3 is subject to a special disadvantage in connection with its relationship to District 2, because companies operating in both districts, particularly those with refineries in the latter, seem to have concentrated their share of the available manpower and equipment in areas where the production obtained could be made available to refineries. That undoubtedly accounts for the fact that District 2 completed 94 per cent of its share of the original PAW program. Furthermore, much of District 2 is covered by PAO amended orders, permitting 10 and 20-acre spacing.

The conditions that affected Districts 1 and 5, namely shortages of manpower and drilling equipment plus low price, are common to all districts. Therefore it is reasonable to believe that these factors had the same influence in Districts 2, 3 and 4. Manpower, drilling equipment and price are listed by almost every operator as major handicaps. It seems safe to assume that for the entire United States, 10 per cent of the first quarter deficit can be charged to these three conditions, and the remaining 4 per cent charged to transportation shortages in Districts 3 and 4.

Operators stress the fact that the manpower situation is becoming progressively worse. Conditions at the beginning of the year were far better than they are now. The latest moves in connection with the drafting of previously deferred young men promise to aggravate the present conditions, regardless of how successful PAW may be in obtaining some deferments. Drilling contractors claim, and the figures bear them out, that the drilling time on wells is constantly increasing. On deep wells, in some cases, drilling already requires 25 to 50 per cent longer than normal. Some of this has been due to the condition of the equipment, and time should remedy this factor. The major part, however, has been due to green labor and lowering of the physical standards for the available employes.

The older the drilling equipment being used, the more important it is that the drilling crew should be made up of skilled and experienced men. The exact opposite prevails.

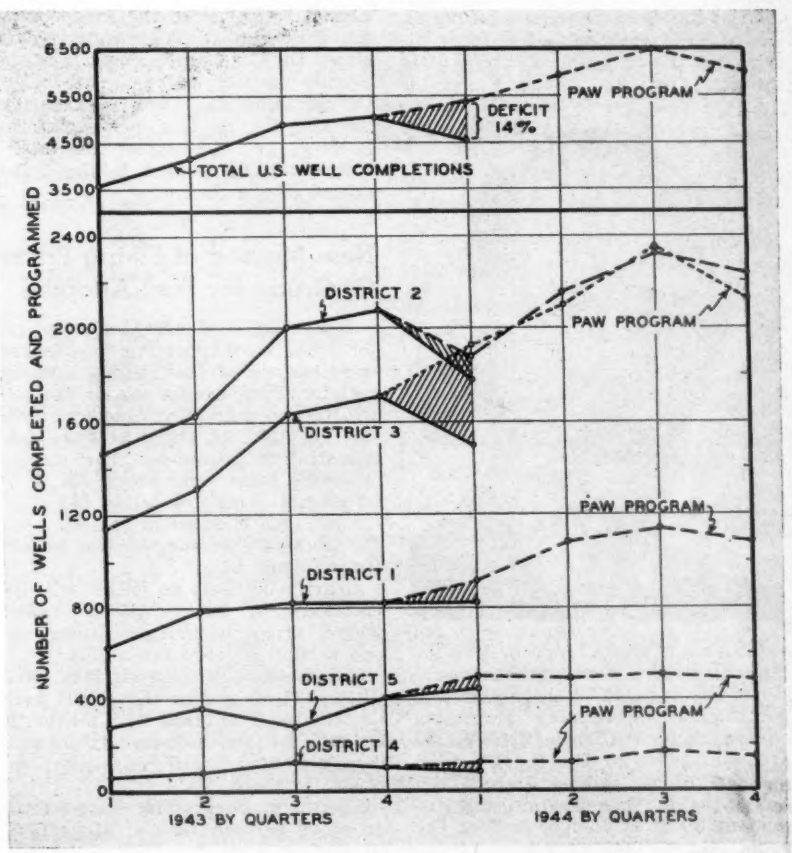
The original PAW 1944 program of 24,000 wells called for a 33⅓ per cent increase over 1943, and an average of

TABLE 1—FIRST-QUARTER COMPLETIONS VS. PAW QUOTA

PAW District:	Quota	Actual	Wells short	Per cent short of quota
1	935	828	107	11
2	1,900	1,778	122	3
3	1,940	1,500	440	23
4	125	98	27	22
5	500	450	50	10
Total	5,400	4,654	746	14

TABLE 2—QUARTERLY COMPLETION QUOTAS

PAW District:	First	Second	Third	Fourth
1	935	1,090	1,140	1,085
2	1,900	2,160	2,330	2,240
3	1,940	2,125	2,350	2,130
4	125	130	175	150
5	500	495	505	495
Total	5,400	6,000	6,500	6,100



6,200 wells per quarter for the last three quarters of 1944. If the revised PAW program is reduced to 21,000 wells, the last three quarters of 1944 must average about 420 wells per week, or about 60 wells per week increase over the first-quarter average. The Journal's weekly completion chart (see p. 321) shows that the 420-well rate was achieved in only 3 weeks out of the entire year 1943, all in the last quarter. The manpower situation is definitely much worse now, and it is questionable whether the anticipated increased flow of drilling equipment will reach the field operating level fast enough to overcome the depreciation in existing materials.

Many operators point out that the petroleum industry is being treated on the same basis as new war industries such as shipyards and airplane factories, where mushrooming growth resulted in inefficient use of labor and in many instances large-scale hoarding of manpower. The petroleum industry, on the other hand, aside from the big construction jobs in refining and pipe lines, has been getting along with fewer employes since the start of the war. Now, with the oil requirements of the armed forces approaching a peak, the drilling and production branches are expected to carry the heaviest load in their history. They cannot carry this load, operators insist, if their already depleted manpower is to be raided again.

R. B. Tuttle Joins the Journal's Refinery Engineering Staff

R B. TUTTLE, who has joined the refinery engineering staff of The Oil and Gas Journal, will bring to its readers 22 years of practical experience in the design, construction and operation of petroleum refineries. He started work in the refinery division of the oil business shortly after he completed his schooling and his

experience covers a broad field in the industry's manufacturing activities.

He was engaged in the design and construction of refinery processing equipment for the Leader Iron Works as an assistant to Dr. E. H. Leslie, manager of the process division. He served as job construction superintendent for E. B. Badger & Sons Co. From 1932 to 1941 he was chief engineer of J. P. Devine Manufacturing Co., manufacturers of refinery equipment.

Tuttle's training also includes experience in construction and operation at refineries of the Independent Oil & Gas Co., Tide Water Associated Oil Co., Lubrite Division of the Socony-Vacuum Oil Co., Inc., Lion Oil Refining Co., and the Sinclair Refining Co. He is a member of the Society of Mechanical Engineers. Tuttle will be located in the Tulsa offices of the Journal.

New Method of Fixing Prices Of Crude for Fuel Adopted

WASHINGTON.—Maximum prices for crude oil conforming to standard specifications of fuel oil and sold direct to consumers for use as fuel oil will be determined by a new method, starting April 14, Office of Price Administration announces. The change is in the form amendment No. 4 to Maximum Price Regulation 88.

Four area changes in fuel-oil ceiling prices are announced also, all effective April 14.

Gravity brackets no longer will be employed in fixing specific tank-wagon prices to industrial users in and around Chicago for residual fuel oils and blends of these oils with distillates. Three grades of residual fuel oil will be recognized, and the basis for each will be viscosity. At present there are about 70 different maximum prices for these oils.

Specific maximum prices are established on kerosene and distillate fuel oil sold in bulk lots f.o.b. refineries in Wayne County, Michigan, for shipment to any destination other than District 1.

Specific maximum tank-wagon prices are established on sales of gasoline to consumers in the San Luis Valley, Colorado. The new ceilings are 1 cent a gallon higher than formerly.

Maximum prices are established at ⅛ cent a gallon off tank-car ceilings on barge shipments of gasoline f.o.b. refineries in designated counties of Kentucky and nearby Indiana to areas other than the eastern seaboard.

Crude Ceilings Higher in Two California Pools

WASHINGTON.—Higher price ceilings, effective April 14, for crude oil produced in two California pools are announced by Office of Price Administration. The increases will be absorbed by refiners, and there will be no change in prices for products made from this crude.

Mountain View field, Kern County, gets increases ranging from 1 to 18 cents a barrel in its maximum prices, depending on the gravity. The field's production averages 27 to 27.9 gravity, and the maximum price is raised from $1.01 to $1.15 a barrel. Current daily production is 3,300 bbl.

Oak Canyon field, Los Angeles County, gets a maximum price of 95 cents a barrel for crude between 20 and 28 gravity. Previously, the ceilings ranged from 87 cents to 94 cents a barrel. Thus, the increases range from 1 to 8 cents a barrel. Current daily production is 960 bbl.

At the same time OPA named specific maximum prices for higher and lower gravity crudes in California fields than those heretofore provided with specific ceilings. The maximum prices added will cause no change in selling prices as they are the same as the October 1, 1941, posted prices for these gravities which have been observed since then.

Panhandle P. & R. Suspends Plan for Work in Mexico

NEW YORK.—Panhandle Producing & Refining Co. has temporarily shelved its plan of forming a company to conduct oil and gas operations in Mexico, Serge Rubinstein, president, told stockholders in his annual report last week. The management is continuing its investigation into possibilities offered in that country, he said.

Simrall Advances Price

MOUNT PLEASANT, Mich.—Simrall Corp. has advanced the price of Fork Township, Mecosta County, crude to $1.44 a barrel. The new posting is effective as of April 1.

FOUNDED IN 1910

BY PATRICK C. BOYLE

the OIL AND GAS JOURNAL

Applied Petroleum Science

ONE of the commentators in this Annual Refinery Number says: "We have been saying for years that applied science would meet any future problems of the oil industry—now we are really convinced."

The numerous applications of science in today's refinery processing and the opinions of leading builders and operators regarding the future, as reported in this issue, should convince the most skeptical that the manufacturing division of the oil business has those qualities of initiative and practical accomplishment which of themselves are a guarantee that future problems will be solved.

The war, possibly more than anything else, has emphasized the flexibility of present-day refinery operations. One operator adds catalytic cracking and alkylation to his existing facilities and obtains large yields of 100-octane gasoline. Another refiner finds uses for processing equipment designed to isomerize liquid fractions.

Other refineries using largely the same equipment are so operated that they furnish needed yields of butadiene for synthetic-rubber manufacture. The tools of hydrogenation and dehydrogenation are utilized in well-rounded operations to get the largest possible yields of war products. All these distillation operations are accompanied by superfractionation which separates petroleum hydrocarbons for use or for further processing in a manner not believed possible even 2 or 3 years ago.

The amazing fact in these operations is that they all use crude oil of the same general specifications. With the new techniques in refining, the quality of raw material is becoming less and less important. It is also true that while there is war demand for every petroleum product now being refined, the processing arts have advanced to the point where, if the need arose and prices justified, the essential peacetime products could be obtained from a smaller volume of crude oil. As was apparent from the reports of the American Chemical Society meeting last week, the possible sources of the most sought hydrocarbons, within and without the petroleum industry, are constantly expanding.

These accomplishments spring from a quarter-century of research and development on the part of this industry's manufacturers. The war would have been lost to this country and its allies had operators not been able to step out of their laboratories with the scientific knowledge and experience advanced to the point where they could be utilized quickly in plant processing.

Applied refinery technology has not yet reached its limit. Those in closest touch with conditions agree that it has just started. Some of the world's largest and most complete laboratories operated by oil companies, and now devoted to the needs of the war, will resume their peacetime activities immediately after the conflict ends.

What has been done in support of the war will not be lost. These emergency operations, in fact, have made it possible to solve quickly many of the problems of permanent operations which will be expanded and perfected.

Washington's planning should include a careful study of the significance of what has happened within refinery gates over the past 2 years. If this is done there will be no concern regarding petroleum's future in this country, and the strange proposals revolving around international oil, now under consideration, involving major changes in our economic and political philosophies, will end.

Germany in Critical Need Of Ploesti Oil

WASHINGTON.—With the Russians bombing railroad yards at Ploesti, center of the big Rumanian oil fields, special interest attaches to the analysis issued by Leo T. Crowley, foreign economic administrator, of the economic significance of the Russian invasion of the Balkans. Raids on Ploesti are essentially a blow at Germany's oil supply, since oil from that area must be moved by rail to the Danube for shipment to war industries in Germany.

Rumania has been providing about 70 per cent of the nonsynthetic oil production available to Germany. Some 145,000 bbl. of oil daily has been coming from Nazi occupied countries, and 100,000 of this is said to have been contributed by Rumania.

"If the Ploesti oil fields in Rumania were captured or cut off," says Crowley's analyses, "Germany would lose about one-third of its total supply of natural and synthetic oil. Loss of the chrome of the Balkans and Turkey would deprive Germany of virtually its entire supply of a vital ferro-alloy and would have an immediate and serious effect on the production of steel for Germany's armaments industry, already seriously hit by British and American air bombardment.

'In spite of Germany's determined efforts to increase production of synthetic oil, the enemy's oil supply has remained at a low level. With the help of Rumanian oil, it has so far been possible for Germany to provide sufficient oil for its air forces, army and navy at the expense of drastic curtailment of civilian consumption. The loss of Rumanian oil production and of lesser amounts of oil obtained from Hungary could not be offset to any substantial extent by increased synthetic production or further industrial curtailment and Germany's military operations and entire war economy would consequently be rapidly affected."

Cost of California Gas Line Estimated at $50,000,000

WASHINGTON. — Construction of a natural-gas pipe line from West Texas to Los Angeles, a project under preliminary discussion, would cost $50,000,000, according to estimates here. Such a line is regarded as a long-range necessity to relieve the shortage of gas developing in the southern California region.

Oil-company officials of the Mid-Continent territory have joined in a study of the plan, which has been broached to War Production Board. Approval would have to be obtained from Federal Power Commission and Petroleum Administration for War, as well as from WPB. If a new pipeline company were created, its formation and financing would have to be approved by Securities Exchange Commission.

Petroleum Electric Groups To Meet in Dallas

The seventeenth annual conference of the Petroleum Industry Electrical Association and Petroleum Electric Supply Association will be held April 19-20 at the Baker Hotel, Dallas. Eight technical papers will feature the conference.

The papers and their authors are:

"Communication Circuits for the Big Inch Pipe Line," by R. W. Perkinpine, American Telephone & Telegraph Co.

"Electronics and the Oil Industry," by W. G. Taylor, General Electric Co.

"Grounding," by J. R. Eaton, James G. Riddle Co.

"Rectifiers—All Types, Comparisons and Applications," by R. T. Fryer, Westinghouse Electric & Manufacturing Co.

"Pipe-Line Coatings," by Starr Thayer.

"Cathodic Protection and the Petroleum Industry Electrical Association."

"Oil and Electricity in Industrial Development," by J. B. Thomas, Texas Electric Service Co.

"The 100 Per Cent Efficient Pipe Line," by Morris Chambers, Standard Oil Co. of Louisiana.

A joint banquet of the two groups will be held in the evening of April 20.

Raymond Moley to Address I.P.A.A. Directors Meeting

Raymond Moley, journalist and professor, and Newsweek's editor on national affairs, will be the principal speaker at the midyear meeting of the directors of the Independent Petroleum Association, to be held at Bradford, Pa., April 27, 28, and 29.

Moley will talk on "The Political Outlook" at a luncheon meeting of the directors Saturday, April 29. He was editor of Today magazine from 1933 to 1937, when he became associated with Newsweek magazine. Moley has been instructor in Ohio public schools and professor of politics at Western Reserve University and is the author of many publications on government and crime surveys.

The 3-day meeting of the directors will place special emphasis on secondary-recovery operations and a national oil policy.

DEATHS

A. Burnie Chastain, 54, accountant for Skelly Oil Co., Tulsa, died in a Tulsa hospital April 8.

George A. Orrok, 77, consulting engineer for New York Edison Co., died April 6 at his home in Riverside, Conn. Research contributions of importance were made by him in the field of heat transfer, in condensers and furnaces. He organized and directed research on the properties of high-pressure steam. He also worked on problems connected with gas and diesel engines.

Theodore Franklin Hook, active in the Alberta oil industry since 1926 and secretary of Nordon Oils, died at Calgary recently.

Roscoe M. Clark, 63, an accountant for the Ohio Fuel Gas Co. for 26 years, died April 1 in Mercy Hospital, Columbus, Ohio.

Thomas L. Wheeler, 47, independent oil operator, died at his home in Wichita Falls, Tex., April 3. He was employed by Invader Oil Co. and Lowry Oil Co., Tulsa. He had been in business for himself since 1929.

S. A. Miller, 70, employed by Atlantic Refining Co. at Port Arthur, Tex., died April 3.

Samuel S. Holtz, 46, employed in the Tide Water Associated Oil Co.'s pump station at Rixford, Pa., died April 1 in an Erie, Pa., hospital.

Kirby Sharp, 41, independent oil man of Sinton, Tex., and candidate for mayor, died of a heart attack at his home April 2.

Harry Gardner Wood, 52, consulting electrical engineer with Worthington Pump & Machinery Corp., Harrison, N. J., died April 4. He graduated from University of Illinois in 1914, served as a captain on the general staff in World War I, and worked for Westinghouse Electric Co. till he joined Worthington in 1930.

Homer V. Evans, Hankamer, Tex., employed by Edwards Drilling Co., died April 5 of injuries suffered in an oil-field accident at Fig Ridge.

Roy L. Carter, veteran oil operator, died April 6 at his home in Wichita Falls, Tex. He was a pioneer in development of the Burkburnett field and was credited with having drilled more than 500 wells in Texas. He had important interests in Oklahoma also.

William Myers, 70, for many years an independent oil producer, died April 5 in Franklin, Pa.

George W. Boyd, 82, for 25 years employed by Mid-Continent Petroleum Corp. until his retirement 2 years ago, died April 9 at his home in Tulsa. He was a telegraph operator at the time of his retirement and before that was district foreman's clerk at Hominy, Okla.

Production of Natural Gasoline and Cycle Products to Rise 27,000 Bbl. Daily

by H. Stanley Norman

The N.G.A.A Section, including the Journal's survey of natural gasoline and cycling plants starts, page 281.

AN increase of nearly 27,000 bbl. in the daily production of natural gasoline, cycle products and allied petroleum hydrocarbons will be realized by the fourth quarter this year when 12 major projects now under construction are placed in operation. Other cycling and natural-gasoline plants are under consideration and may be programmed in time to fill a position in the industry's war-production assignment.

The projected additions to manufacturing capacity of natural gasoline and cycling plants are in addition to several other major construction jobs recently completed or currently nearing the operating stage. One of the industry's largest cycling plants in the Erath field, South Louisiana, is described in fuller detail starting on page 295.

Texas fields have 8 of the 12 large plants currently covered by Petroleum Administration for War's Program Determination 455. The other four projects are divided among Arkansas, Louisiana, California and New Mexico.

Most of the new plants currently under construction were authorized during the latter part of 1943 when it became evident that the increased demands for military fuels would require further expansion in the natural gasoline and cycling capacity. The ultimate objective of the PAW Natural Gas and Natural Gasoline Division is to increase manufacturing capacity 35,000 bbl. daily, indicating that approximately 77 per cent of the original program is covered by the 12 plants now under construction.

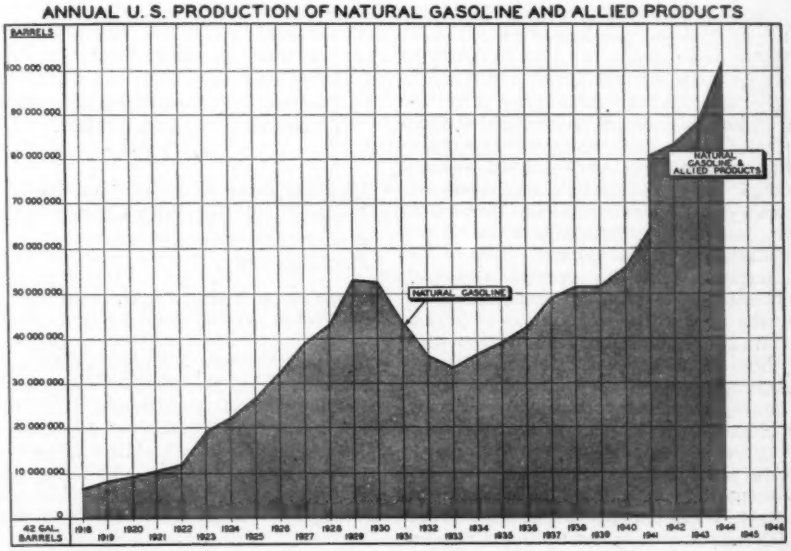
Without benefit of the wartime-authorized facilities, the industry has increased its production capacity to roughly 285,000 bbl. daily compared with about 265,000 bbl. per day at the middle of 1943. Most of the increase currently reflected in production operations is attributable to installation of additional towers in existing plants, consolidation of less efficient facilities and in a moderate scope of new construction which was authorized earlier in the war.

The natural gasoline industry, holding its annual meeting this week in Dallas, is enjoying an appreciation for its efforts exceeded by no other branch of the oil business. This appreciation is based chiefly on the determination that more desirable hydrocarbon fractions can be obtained from natural-gasoline and cycling plants, particularly the latter, than through any other production operation with a given amount of steel with which to fulfill the assignment. Furthermore, the industry's products are one step nearer the finished 100-octane gasoline and synthetic rubber than it is possible to obtain through other commercial methods of manufacture. Isobutane, for example, recovered in various volumes at most of the modern natural-gasoline and cycling plants, is the most desirable olefin in production of alkylate.

NATURAL GASOLINE AND CYCLING PLANTS UNDER CONSTRUCTION

Company and plant—	Cost	Proposed production (bbl. dly.)	Estimated completion date
The Texas Co., Bateman Lake, La.	$1,071,000	1,100	October
Shell Oil Co., Inc., Sheridan, Tex.	2,450,500	6,100	October
J. S. Abercrombie and Magnolia Pet. Co., Old Ocean, Tex.	2,851,000	5,640	September
Humble Oil & Refining Co., Katy No. 2, Tex.	4,600,000	6,980	June
Phillips Petroleum Co., Seminole, Tex.	1,165,000	2,050	June
Phillips Petroleum Co., Eunice, N. M.	536,000	435	May
Barnsdall Oil Co., Newhall Potrero, Calif.	333,000	480	July
Barnsdall Oil Co., Midway, Ark.	436,000	400	June
Sinclair Prairie Oil Co., Arp, Tex.	124,000	400	June
Shell Oil Co., Inc., Wasson, Tex.	1,450,000	1,380	August
The Chicago Corp., Stratton, Tex.	222,000	350	August
Trinity Gas Corp., Sejita, Tex.	950,000	1,580	July
Total	$16,188,500	26,895	

ANNUAL U. S. PRODUCTION OF NATURAL GASOLINE AND ALLIED PRODUCTS



Alkylation, Catalytic Cracking, Hydrocarbon Properties Discussed by American Chemists

CLEVELAND.—Reactions of hydrocarbons under the influence of cracking catalysts, alkylation by means of catalysts, especially hydrofluoric acid, were among the highly interesting and important subjects discussed by the members of the American Chemical Society at its spring meeting in Cleveland last week. Hedged about by numerous restrictions as to the processes, the reactions themselves were discussed in somewhat guarded manner under wartime censorship limitations.

Studying methylcyclopentane, a not too common isoparaffin, in conjunction with HF and with H_2SO_4 as catalysts in the presence of olefins in alkylation shows a large number of side reactions, Herman Pines and V. N. Ipatieff, Universal Oil Products Co. researchers have discovered. Using the olefins propene, n-butenes, isobutylene, pentene-2, 3-methylbutene-1, and 2,2,4-trimethylpentene-1 and -2, they found that in addition to the main alkylation reaction, a simple addition of olefin to isoparaffin, other reactions which occurred are: (1) addition of olefin and isoparaffin with ring opening and migration of the side chain; (2) isomerization of straight chain olefins to isoolefins, plus hydrogenation, that is, isoparaffins from normal olefins; (3) depolymerization or depolyalkylation; (4) production of polycyclic olefins or paraffins from olefinic or polyolefinic naphthenes, and some other reactions.

Methylcyclopentane reacts with n-butene in the presence of sulfuric acid to form 1,3,5-dimethylethylcyclohexane, and 1,3-dimethyl-4 ethyl cyclohexane. Reaction of isobutylene with methylcyclopentane was quite complicated in presence of sulfuric acid catalyst. Large percentages (25 per cent) of isobutane was formed by transfer of hydrogen to saturate the olefin; hydropolymers were also formed from the polymerization of the olefin and subsequent hydrogenation or from hydrogenation of part of the olefin to isobutane and the reaction of this by alkylation with remaining olefin, forming octanes in either case. About half the methylcyclopentane which reacted formed polycyclic saturates while the remainder was partially dehydrogenated and formed combinations with the catalyst. With pentene-2 the main reaction is isomerization and hydrogenation to isopentane; hydrogen needed came from the condensation-polymerization of methylcyclopentane to duodecanes, etc. About one-fifth of the pentene polymerized to decenes and they were hydrogenated to decanes.

The reactions between olefins and isoparaffins vary considerably with temperature with HF as catalyst, C. B. Linn and A. V. Grosse of the Universal laboratory have found. At very low temperatures polymerization of the olefin is the main reaction. As temperature rises above optimum for alkylation, side reactions occur which form less desirable products and decrease yields of the desired alkylate. Yields of 50 to 75 or 80 per cent of alkylate of 91-92 octane number (A.S.T.M.) were obtained at various temperatures.

Reactions between isopentane and propylene show yields as high as 272 per cent of the olefin which reacted; only one-fourth of the product boiled in the range of octanes, showing a nonselective reaction with many side reactions, a fact which was corroborated by finding considerable amounts of isobutane in the products. Isobutane could be formed only by scission of the i-pentane molecule with loss of a methyl group; this group might migrate to a propylene molecule and form a C_4 olefin therefrom. This nonselective reaction is said to be typical of alkylation with pentane as the isoparaffin, the yields being greater than the theoretical based on the olefin reacted in equimolecular proportions with isopentane. The primary alkylation reaction is promoted by high isoparaffin:olefin ratios. Presence of water in the catalyst or reacting mixture reduces catalyst activity, water probably having greater effect in this way than any other commonly occurring diluent.

It will require 2 years to replace the automobiles which have been lost to service, after the war is over, A. H. Adams and B. H. Weil of Gulf Research & Development Co., point out, in discussing postwar cars and fuels. Only after that period can the postwar car be designed and supplied to consumers, they stated. Hundred-octane number fuels may eventually find a use in motor cars, but just following the war 80 octane will probably represent the major portion of fuels supplied.

A.C.S. ABSTRACTS

The accompanying abstracts indicate the various directions of attention in modern research programs and some idea is given of the state of the art in the results obtained. Gas chemistry, catalytic-cracking methods and results, solvent treating and synthesis of pure hydrocarbons are some of the subjects covered in the papers before the Petroleum Division, American Chemical Society in Cleveland, April 3-7, 1944.

Hydrocarbon Reactions in the Presence of Cracking Catalysts. 3. Cyclohexane, Decalin And Tetralin

HERMAN S. BLOCH and CHARLES L. THOMAS, Universal Oil Products Co.

A STUDY was made of the reactions, at atmospheric pressure, of cyclohexene in the presence of a synthetic silica-aluminathoria catalyst at 250°-400°; of tetralin with a synthetic silica-alumina-zirconia catalyst at 400°-500°; and of decalin with the latter catalyst in both the fresh and partially spent state at 400°-500°.

The principal reaction products isolated from cyclohexene were methylcyclopentenes-1 and 2, methylcyclopentane, a mixture of unidentified liquids boiling higher than cyclohexene, and 2,6-dimethylnaphthalene. The principal reactions of cyclohexene under the conditions studied were (1) isomerization, (2) polymerization, and (3) hydrogen transfer. The hydrogen transfer was primarily from the polymer resulting in the formation of dimethylnaphthalenes and the hydrogenation of the methylcyclopentenes to methylcyclopentane.

Naphthalene was the product formed most abundantly from tetralin.

Scission of the hydroaromatic ring gave benzene, toluene, xylenes, possibly ethylbenzene, and higher boiling alkylated benzenes. No alkenylbenzenes were isolated. They might have been formed and then converted into the corresponding alkyl derivatives by hydrogen made available by the conversion of tetralin to naphthalene. Some of the tetralin was converted to bicycloparaffins, presumably decalin or its isomers. The products can be explained by reactions of (1) scission of the hydroaromatic ring and (2) hydrogen transfer. Apparently isomerization also occurred, for the xylene fraction contained xylenes other than o-xylene.

The chief products formed from decalin were decalin isomers, C_3 and C_4 olefinic and paraffinic gases in which isobutane predominated, methylcyclopentane, and probably cyclohexane and the corresponding olefins. In addition, tetralin or its isomers was found, and the aromatic reaction products of tetralin conversion indicated above. The products can be explained by the following reactions of decalin and the intermediate tetralin: (1) isomerization, (2) ring scission, and (3) hydrogen transfer.

Reaction of Methylcyclopentane With Olefins in the Presence of Sulfuric Acid and Hydrogen Fluoride Catalysts

HERMAN PINES and V. N. IPATIEFF, Universal Oil Products Co.

THE study of the reaction of cycloparaffins with olefins was undertaken in order to gain a better understanding of the alkylation reaction, since the ring hydrocarbons can readily be detected and identified.

For this study, methylcyclopentane was chosen as the hydrocarbon to be alkylated in preference to the more accessible cyclohexane, for the reason that it undergoes alkylation more readily and at the same time it permits observation of whether or not isomerization of the cyclopentane to cyclohexane ring occurs. It is known that at room temperature the equilibrium is mostly toward cyclohexane side. Alkylation with the following olefins was investigated: propene, n-butenes, isobutylene, pentene-2, 3-methylbutene-1, and 2,4,4-trimethylpentene-1 and 2. The alkylation was carried out in the presence of sulfuric acid and hydrogen fluoride, since these two catalysts, under the experimental conditions used, cause practically no isomerization of saturated hydrocarbons.

It has been found that the reaction of methylcyclopentane with olefins is accompanied by a complex reaction involving (a) addition of olefins to methylcyclopentane accompanied by ring expansion and migration of alkyl groups within the ring, (b) hydrogen disproportionation, the naphthenes being usually the hydrogen donors; whereas the olefins are the hydrogen acceptors, (c) isomerization of normal chain olefins to isoolefins followed by hydrogenation, (d) interreaction of partially dehydrogenated naphthenes to form polycyclic olefinic or polycyclic saturated hydrocarbons, (e) depolymerization and/or depolyalkylation. The ease with which the above-mentioned reactions occur depends to a great extent upon the olefins used. The unsaturated hydrocarbons formed during the reaction are usually found in the catalyst layer, from which they can be recovered by diluting with water.

Hydrocarbon Reactions in the Presence of Cracking Catalysts. 4. Removal of Side Chains From Aromatics

CHARLES L. THOMAS, JAMES HOEKSTRA and JOHN T. PINKSTON, Universal Oil Products Co.

THE cracking of ethylbenzene, cumene, n-butylbenzene, and technical amylbenzene in the presence of synthetic catalysts of the silica-alumina type was studied in the temperature range of 400° to 500° C. and atmospheric pressure. Benzene and the corresponding alkene were formed with ease and great selectivity when the side chain contained three or more carbon atoms. The yield of benzene was at least 90 per cent of theory in each case. The order of decreasing susceptibility to cracking was cumene, the technical amylbenzene, n-butylbenzene, and, in a lower order of magnitude, ethylbenzene. No toluene, styrene, etc., was found in any product in this study.

The alkenes formed apparently underwent subsequent reactions to some extent, for some hexenes were formed in the cumene tests, presumably by polymerization of the initially formed propylene. The olefinic products from butylbenzene underwent the hydrogen transfer reaction; some butanes were formed.

The Alkylation of Isoparaffins By Olefins in the Presence Of Hydrogen Fluoride

CARL B. LINN, Universal Oil Products Co., and ARISTID V. GROSSE, Catalytic Development Co. (Contribution of Universal Oil Products Co.)

HYDROGEN fluoride catalyzes the interaction of olefins and isoparaffins to form saturated products consisting of highly branched paraffinic hydrocarbons. The alkylation was carried out, both in continuous and batch operations, in the laboratory. The effects of temperature, contact time, isoparaffin to olefin ratio, and catalyst concentration were studied.

Runs involving the paraffins isobutane and isopentane, and the olefins, propene, isobutylene, butene-1 and butene-2, are reported; also the production of alkylate from a mixture of butanes and butylenes.

Normally the fluorine content of the alkylate is low and can be reduced by further treatment.

Vapor Pressures in Hydrocarbon-Furfural-Water Systems

CLARK HOLLOWAY, Jr., and S. H. THURBER, Gulf Research & Development Co., Pittsburgh, Pa.

SYSTEMS of four hydrocarbons with a furfural-water solution have been studied with respect to cloud point, vapor pressure, and density. Isobutane was found to be the least soluble in the 4 weight per cent water-96 weight per cent furfural mixture, followed by n-butane, butene-1, and butadiene-1,3. Isothermal vapor pressure and density data were also taken at four temperatures above the cloud point curves: 250°, 200°, 150° and 100° F. These vapor pressure data permitted the calculation of activity coefficients which are presented as plots of γ versus x for each system at the four temperatures listed. Experimental vapor pressures for butene-1 and butadiene-1,3 are given up to 250° F.

Hydrocarbon Reactions in the Presence of Cracking Catalysts. 2. Hydrogen Transfer

CHARLES L. THOMAS, Universal Oil Products Co.

NORMAL octenes were converted by a synthetic silica-alumina-zirconia catalyst at 375° C. mainly into octanes, aromatic hydrocarbons, and a hydrogen-poor catalyst deposit. The reactions that occurred were:

1. Hydrogen transfer reactions resulted in the conversion of olefins into paraffins. At the same time, products poorer in hydrogen, such as aromatic hydrocarbons and the catalyst deposit, were formed.

2. Isomerization; earlier work showed that n-octenes isomerized rapidly in the presence of this type of catalyst. In the present test the iso-C_8 fraction constituted 93 per cent of the C_8 cut.

3. Scission of carbon-carbon bonds to form products containing fewer than eight carbon atoms; the tendency of this type of catalyst to form cracked products containing three or more carbon atoms was again demonstrated.

4. Polymerization or condensation to form products containing more than eight carbon atoms; these products included higher boiling liquids as well as the solid and semisolid material deposited on the catalyst.

5. Cyclization; aromatics within the boiling range of the xylenes, as well as still higher boiling aromatics, were formed. The formation of the aromatics may have been preceded by the formation of the corresponding

cycloparaffin. The evidence for the presence of the cycloparaffins is less convincing than that for the aromatics.

Some of the commercial processes for producing aviation fuel, contact gasolines containing olefins with cracking catalysts to reduce the olefin content, increase the aromatic content, and improve the susceptibility to tetraethyl lead. The reactions described in the present article aid in understanding the chemistry of these processes.

Selectivity of Solvents for Various Types of Hydrocarbons as Measured by Critical Solution Temperature

ALFRED W. FRANCIS, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.

CRITICAL solution temperatures have been determined for over 100 solvents of various types with 10 representative hydrocarbons, 2 straight-chain paraffins, a branched-chain paraffin, 2 olefins, 2 naphthenes, paraffin wax, and 2 commercial oils. Aromatic hydrocarbons are too miscible with these solvents to observe the critical solution temperature.

The differences in C.S.T. for the same solvent with different hydrocarbons is taken as a measure of the relative affinity or selectivity of the solvent for the two types of hydrocarbon. Selectivities for olefins, naphthenes, branched chains, type of oil, and molecular weight are calculated and plotted against each other to show their extent of interrelation.

Effects of substituent groups in the solvents are estimated. The methyl and phenyl groups usually lower the C.S.T. about 40° C. The nitro and carboxyl groups raise it over 100° C.

Pressure Dependence of the Rate Of Gasification of Carbon

B. R. WARNER, U. S. Bureau of Mines, Pittsburgh, Pa.

NEW experimental proof has been obtained for the existence of isotherms and saturation pressures in the reaction between steam and carbon. These isotherms are of the form similar to the adsorption of a monomolecular layer of a gas on a solid adsorbent.

An apparatus is described in which the rate of gasification can be studied over a large pressure range on a single sample of carbon. In this apparatus it is possible to change the pressure and steam velocity rapidly, and the small amounts of gas formed in a very short time can be measured so that the sample is not consumed to any appreciable extent between measurements. Advantage is taken of the fact that the primary gasification involves only the formation of carbon monoxide and hydrogen (the carbon dioxide being formed by the water-gas reaction), so that by oxidizing these gases with copper oxide, only carbon dioxide and water are left. The rates of gasification are obtained by measuring the carbon dioxide pressure formed in a known volume (after condensing the water) at the end of a definite reaction time interval.

Quantitative Liquid-Phase Hydrogenation of Hydrocarbons

MILTON ORCHIN and E. H. KAPLAN, U. S. Bureau of Mines, Pittsburgh, Pa.

THE amount of unsaturation in 12 Fischer-Tropsch oils produced in the Bureau of Mines experimental plant has been measured by quantitative liquid-phase hydrogenation at room conditions, using a platinum oxide catalyst. The amount of unsaturation as determined by hydrogenation agrees well with that determined by bromine titration.

When unsaturated compounds are hydrogenated in the liquid-phase Raney nickel, the hydrogen gas associated with the nickel participates in the reaction, and less than the theoretical quantity of added hydrogen is absorbed. After the same nickel has been used twice, nearly all the reactive hydrogen gas associated with it is consumed and quantitative studies with this used nickel give theoretical results. The associated hydrogen can also be eliminated by heating a suspension of the nickel, but this treatment impairs its catalytic activity.

Combustible Gases as Substitute Motor Fuels

GUSTAV EGLOFF and MARY ALEXANDER, Universal Oil Products Co., Chicago, Ill.

COMBUSTIBLE gases have replaced over 3,000,000 bbl. of gasoline in the operation of about 140,000 motor vehicles in Europe, since these gases come from domestic sources. Even in the United States, propane and butanes are used in about 25,000 vehicles. Methane, ethane, propane, and the butanes are obtained from oil and natural-gas wells, refineries, coal mining and processing, sewage, and city gases. Acetylene, ammonia, and hydrogen are used in countries particularly where there is abundant water power to furnish electric energy. Utilization of all these fuels has been limited in Europe, since high-pressure equipment requires materials of which there is a shortage. Although at present the equipment is much heavier, the fire hazard greater and commercial distribution poorer than with gasoline, gases may play an important role in the future of motor transport.

Phase Equilibria in the Ethane-Ethylene-Acetylene System

J. LLOYD McCURDY, Standard Oil Co., California, and D. L. KATZ, University of Michigan.

AN experimental study of the phase equilibrium relationships of the ethane-ethylene-acetylene system has been carried out at two temperatures, 40° and 60° F., and at a series of pressures in 50-lb. intervals covering the entire two-phase region at each temperature.

The constant boiling mixtures of the ethane-acetylene and ethylene-acetylene system persist through the triangular three-component diagrams. At constant temperature and pressure these diagrams have two two-phase areas. Acetylene is the most volatile constituent in one area and the least volatile in the other area.

Colombian Production Drops From Wartime Peak

NEW YORK.—Crude-oil production in Colombia in January totaled 1,266,034 bbl., a decline of 583,947 bbl. from the December total of 1,849,981 bbl. December's total was the highest since Colombia set a record in February 1942, of 2,336,000 bbl. January's production was the lowest since last July. The January daily average of 40,839 bbl. compared with the December average of 59,677 bbl.

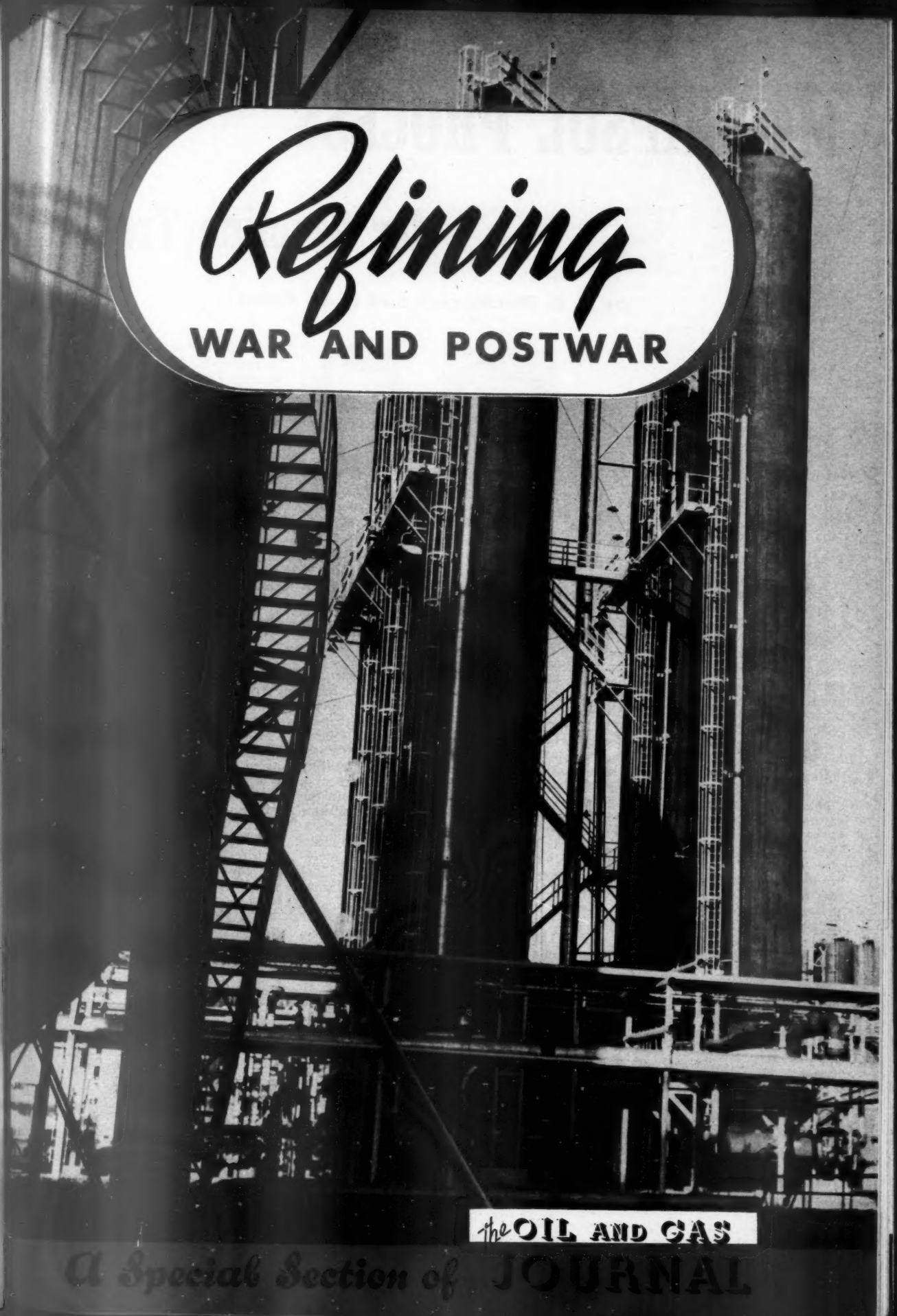
Natural-gasoline production was 351,725 bbl. in January against 17,103 bbl. in December.

The monthly record of Colombian production for the past 2 years follows:

Month—	1943	1942
January	208,532	2,213,000
February	334,211	2,336,000
March	491,656	1,296,000
April	350,367	1,072,000
May	933,514	1,121,000
June	1,243,162	786,000
July	954,972	467,000
August	1,672,560	379,000
September	1,742,186	348,000
October	1,707,173	198,000
November	1,782,898	184,000
December	1,849,981	188,000
Total	13,271,212	10,593,000

Northern Ordnance Adds to Its Pennsylvania Holdings

OIL CITY, Pa. — Additional purchases of oil properties in this region by a representative of John B. Hawley, Jr., president of Northern Ordnance Co., Minneapolis, bring the holdings of that organization to approximately 16,000 acres. The latest acquisitions include more than 5,000 acres of National Petroleum Co., and the holdings of McCormick Oil Co., embracing 160 acres. Last week Hawley announced he had purchased the Clinger Oil & Gas Co. interests, embracing about 10,000 acres. The price was not disclosed in any of the transactions.


Refining
WAR AND POSTWAR
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MERCAPSOL PROCESS

for Gasoline Treating

by B. L. MacKusick and H. A. Alves *

SULFUR and its compounds occur in nearly all crudes produced throughout the world to a greater or to a lesser extent. Besides the extremely serious problem of corrosion to refinery equipment occasioned by this sulfur, many sulfur compounds have offensive odors which the refiners must eliminate before his products are suitable for marketing. The chief offenders in this respect are the mercaptans, a family of sulfur compounds that covers the entire boiling range of petroleum distillates.

Early in the history of the refining of automotive fuels from petroleum, the doctor sweetening process was developed, and it very satisfactorily solved the odor problem at the time. With the advent of tetraethyl lead due to the constant increase in octane requirements, a serious disadvantage to the doctor process came to be recognized. The doctor process converts the mercaptans to the comparatively odorless disulfides, and the disulfides were found to be one of the worst of sulfur compounds in decreasing the effectiveness of tetraethyl lead added to improve the octane rating of fuels.[1,2,4,6,7,8] Mercaptans themselves, although not to quite the same degree as disulfides, seriously affect the lead response of gasoline. The need for a process to remove mercaptans rather than convert them to the undesirable disulfides was thus established.[9,10,11,12,13,14] With this primary consideration in mind the Mercapsol process was developed.

Research and Development

Caustic soda solution has been used for years for treating gasoline to remove mercaptans,[6] but it is not sufficiently selective, even when used in very large proportions, to remove enough of the mercaptans to give a satisfactory product. It was therefore customary to follow the caustic wash by conventional doctor sweetening with its attendant disadvantages. The removal of roughly half of the mercaptans by caustic washing was considered to be good operation, but the reduction of lead requirements by this degree of removal left much room for improvement. The desired process had several basic requirements. Necessary chemicals should be cheap and readily available. The process should be simple and easy to operate in order to reduce labor costs, and mercaptan removal should be substantially complete to eliminate the necessity for any further treatment. The treating ratio should be low to avoid high utility costs in regeneration, and the treating agent should be susceptible to an indefinite number of regenerations to avoid exhaustion of the treating solution. The agent should moreover be not highly toxic and not dangerous to handle to avoid hazard to the refinery's operating personnel.

Caustic soda was selected as the base of Mercapsol due to its cheapness and availability. For the same reason a water solution was considered mandatory to avoid the expense of organic solvents and their losses due to relatively high volatility. An investigation of a large number of substances which would act as promoters to increase the solubility of the mercaptans in the caustic solution resulted in the selection of those components which would fulfill most completely the above requirements. Several different Mercapsol solutions have been demonstrated, both commercially and in the pilot plant, to be of substantially equal effectiveness, and the choice depends largely on the availability due to wartime restrictions, and on the market price. Certain types of naphthenic acids and cresols have proven highly satisfactory as components of the solution, but a wartime substitute of greater availability and substantially equal effectiveness consists of high boiling tar acids which are a byproduct from the coking of coal.[15]

The pilot Mercapsol unit (Fig. 1) consists essentially of a packed treating tower 14 ft. high, and a water wash tower 8 ft. high. The raw gasoline is pumped up through the treating tower and then through the wash tower to remove any traces of entrained solution. The Mercapsol solu-

*The Pure Oil Co., Chicago, Ill.

B. L. MACKUSICK

H. A. ALVES

Receiving primary education in England while living there with his parents, Byron L. MacKusick returned to America to graduate from Winthrop, Mass., high school, later receiving bachelor's and master's degrees from M.I.T. in 1930 and 1931, respectively. He went to work for Socony-Vacuum Oil Co., Inc. in Paulsboro, doing research and development work. He joined Pure Oil Co. in 1936, where he still is employed.

Howard A. Alves received a bachelor of science degree in chemical engineering from University of Texas in 1937, worked for Standard Oil Co. of Louisiana, then returned to his Alma Mater as chemical engineering tutor and graduate student to receive his master of science degree in 1939. Later he joined Pure Oil Co. at its Northfield, Ill., laboratory chemical engineering section and has seen service in Pure refineries in West Virginia, Texas, and Ohio.

The Mercapsol process removes mercaptans from gasoline by countercurrent liquid-liquid extraction. Removal of mercaptans results in improved octane number and lead susceptibility, with economic savings of considerable magnitude. The Mercapsol solution is regenerated by steam stripping indefinitely, with negligible makeup chemical costs. Both pilot-plant and commercial application of the Mercapsol process are discussed herein, and specific data on the treating of various gasolines are presented. A 5,000-bbl. unit has been in successful operation since April 1941, and a 2,000-bbl. unit has been designed and licensed.

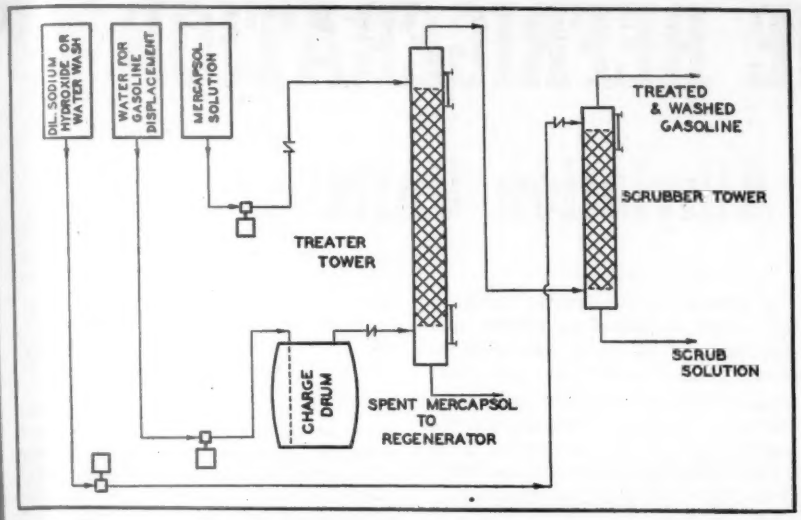

Fig. 1: Flow diagram of pilot Mercapsol unit

tion enters at the top of the treating tower where the liquid interface is maintained, and is withdrawn by manual control from the bottom of the tower. In the pilot plant the spent solution is batch regenerated in an open vessel by diluting with an equal volume of water and then concentrated by boiling to the original volume. This simple procedure effectively removes all the dissolved mercaptans, and the solution may be used and regenerated indefinitely.

Commercial Operation

The Pure Oil Co. has been operating a 5,000-bbl.-per-day Mercapsol treating unit since April 1941 (Fig. 2). Aggressive exploitation of the process has been held in abeyance due to restrictions imposed by the war. However, a 2,000-bbl. plant has been licensed recently and will be operating in the immediate future. This unit is being converted entirely from existing doctor and caustic washing equipment, and no new materials have been required.

The process consists of two relatively independent sections, the treating system and the regenerating system (Fig. 3). Raw gasoline is first prewashed with dilute caustic to remove hydrogen sulfide. This is necessary to prevent sodium sulfide accumulation in the Mercapsol solution, since the sulfide is not eliminated in the regeneration step. The gasoline is then water washed and introduced at the bottom of the treating tower where it rises through the packing countercurrent to the Mercapson solution. The gasoline then passes through a settling chamber and a coalescer tower to remove the last traces of treating agent, is water washed, salt dried, and sent to finished storage.

Spent Mercapsol solution contains a small amount of suspended or dissolved gasoline, and this is removed and returned to the treating tower before the solution is regenerated. The over-all treating loss is thus limited to the unavoidable pumping loss sustained in any gasoline transfer operation. The spent solution is heated to its flash temperature by exchange with the hot regenerated solution supplemented by open steam or a preheater, and is flashed in a tower from which the gasoline and steam are taken overhead and condensed. The hot denuded Mercapsol solution is then introduced to the regenerating tower and is steam stripped to remove the mercaptans. Closed steam heat at the bottom of this tower, or from an external reboiler, generates the steam for this stripping. The hot solution from the bottom of the tower passes through the exchanger previously mentioned, through a final water cooler and then to regenerated Mercapsol storage. Hot water, sufficient to compensate for the stripping steam lost overhead, is introduced to the top of the regenerating tower. This regenerating system employs temperatures no higher than those used in conventional caustic regeneration, and corrosion problems are of the same order of magnitude. The use of 5 per cent nickel tubes in the reboiler has been found entirely satisfactory in the commercial unit mentioned above, and after 2 years of continuous service no corrosion was found in any part of the entire Mercapsol unit.

Data Presentation

Table 1 gives the pertinent pilot-plant treating data on two gasolines, a thermally cracked gasoline from Talco crude containing high mercaptan sulfur, and a Mid-Continent CHP gasoline with comparatively low mercaptan content. The octane and leading data are presented graphically in Figs. 4 and 5. It will be observed

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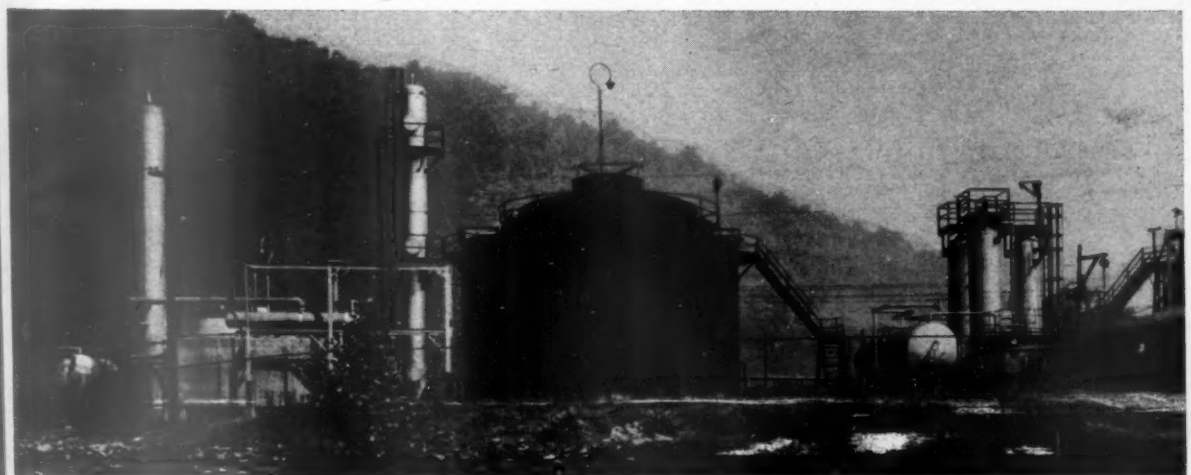


Fig. 2: Five-thousand-barrel Mercapsol unit at Cabin Creek, W. Va. Treating and regenerating towers to left. Caustic prewash and coalescer and salt towers to right, illustrating use of existing equipment without relocation. Center agitators not part of Mercapsol system

PROPANE REFRIGERATION

For Alkylation Units

The operation of propane refrigeration units installed to obtain temperatures of 50° F. or below in the reaction zone of sulfuric acid alkylation plants is described in this discussion. Various features for the purification of the propane to remove sulfur dioxide, water, air and lube oil are explained. The equipment auxiliary to the gas-engine-driven compressors is described. This article was furnished through the courtesy of the refinery operating division of The Texas Co.

CONSIDERABLE experience has been obtained in the design and operation of a number of propane-refrigeration units of 1,000 to 2,000 A.S.R.E. tons (12,000 B.t.u. per hour) capacity operated in conjunction with sulfuric acid alkylation plants requiring temperatures of 50° F. or below in the reaction zone. The first propane refrigeration units installed were modeled after existing ammonia plants and contained many complicated arrangements for propane-heat exchange, transfer, venting, drainage, etc., which have since been found unnecessary.

The use of propane as a refrigerant permits operation of the compressors with discharge pressure of 175 lb. per sq. in. and condensation of the propane at 90° F., basis a maximum water temperature of 80° F. For a reaction-zone temperature of 50° F., propane is normally evaporated at 35° F. and for lower reaction-zone temperatures it is evaporated at correspondingly lower temperatures. When propane is evaporated at 35° F., the compressors may be designed for a suction pressure of about 57 lb. per sq. in.

Source of Propane

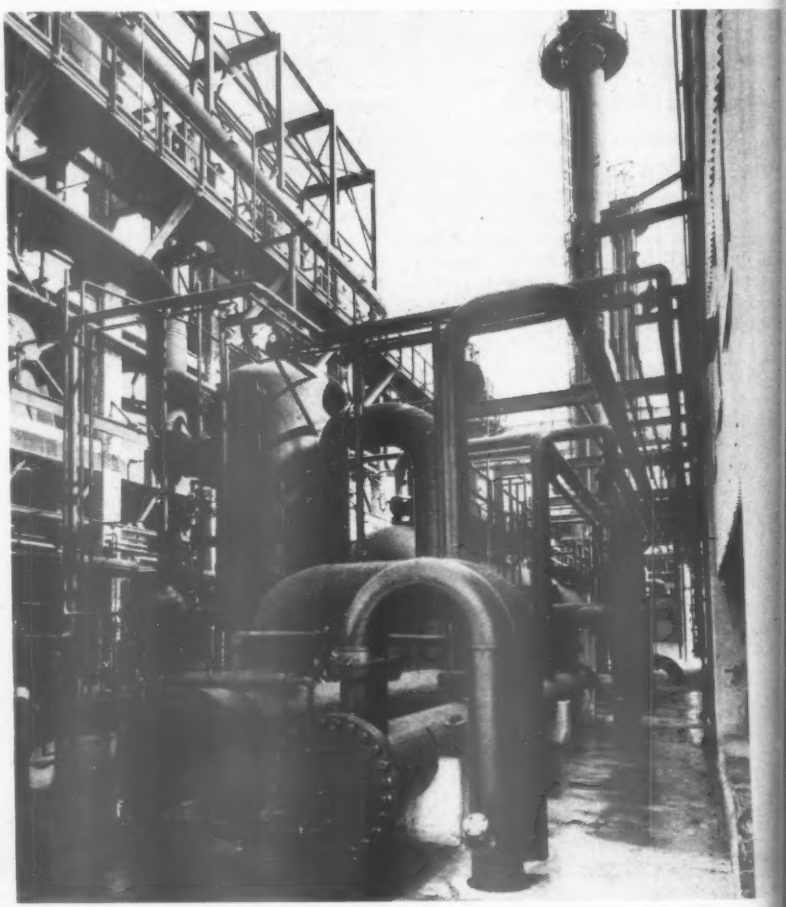
Makeup propane to the refrigeration unit comes from the overhead of the alkylation unit depropanizer tower which serves to depropanize the isobutane-recycle stream. This propane meets all of the specifications for commercial propane given in the "Handbook of Butane-Propane Gases" and usually approaches the properties of pure propane. It is significant that less power is required when using pure rather than impure propane.

The presence of sulfur dioxide has been detected in this propane. Its occurrence is probably due to insufficient neutralization or hydrolysis of the alkylation-reactor effluent before being fractionated. As a result, equipment is usually furnished for the removal of this sulfur dioxide, consisting of a small vessel for settling from the propane stream caustic soda which is recirculated by means of an eductor. If desired, a small packed tower filled with caustic soda may be used instead.

Flow of Propane

The flow of propane is substantially the same as that which would be employed for any other refrigerant. The compressors take suction from the suction trap and discharge directly to the propane condensers, and thence to the receiver. Liquid refrigerant from the receiver flows under its vapor pressure to the chilling equipment whose propane demand is met by a liquid level controller located on the propane accumulator drum at each chiller or alkylation reactor. The propane which is evaporated in the chiller is returned to the suction trap.

To permit condensation of the propane at as low a temperature as possible, a temperature rise of only 5° F. is taken in the condenser water. This will permit a final condensing or subcooling temperature of the propane to within at least 10° F. of the condenser water temperature. Operation in this manner conveniently balances out the water supply when the



Compressor suction and discharge headers and suction trap

water out of the propane condensers is reused in the overhead condensers or product coolers at the alkylation unit fractionating towers.

Propane Transfer

Propane is normally pumped by the transfer pump, when being transferred from one vessel to another at high rates or in large quantities. It is possible, however, to transfer propane from the storage drum to the receiver, or vice versa, by venting one drum to the compressor suction. As mentioned below, use is made of this method when circulating for propane drying.

Propane storage is provided within the refrigeration unit in an amount at least equivalent to the volume of the remainder of the equipment containing propane. To absorb any fluctuations in operations, a surge time of at least 20 minutes is desirable in the propane receiver.

Suction Trap Design

Under normal operation, the propane from the suction trap to the compressor is slightly superheated by virtue of heat gain from the surroundings and pressure drop in the various lines. The use of a suction trap protects the compressors against any momentary upsets in flow which would otherwise permit liquid propane to enter the compressor cylinders. The suction trap is normally equipped with a high-liquid-level alarm and connects to a high-capacity-transfer pump to permit immediate removal of any liquid.

The diameter of the vessel is large enough so that for the maximum in-

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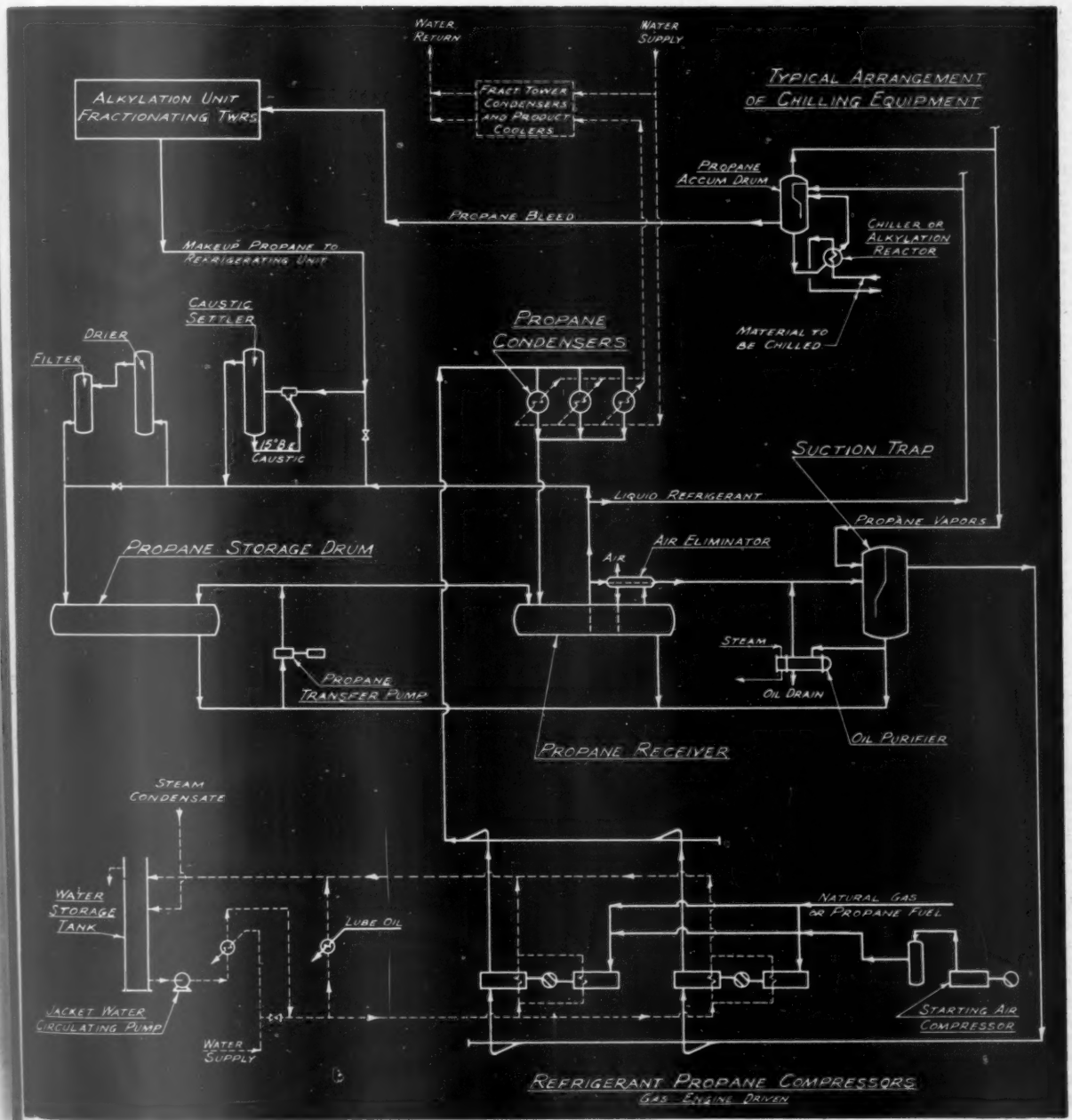
Propane refrigeration unit schematic flow design



Toluene Recovery Plant Employs Azeotropic Distillation

by Arch L. Foster

Formation of an azeotropic mixture with toluene and methyl (wood) alcohol is the chief means employed in Magnolia's toluene recovery unit for the concentration of this all-important aromatic from refinery streams. This mixture boils at a lower temperature than either component when pure; addition of water to the azeotrope overhead stream separates toluene in nitration-grade purity.

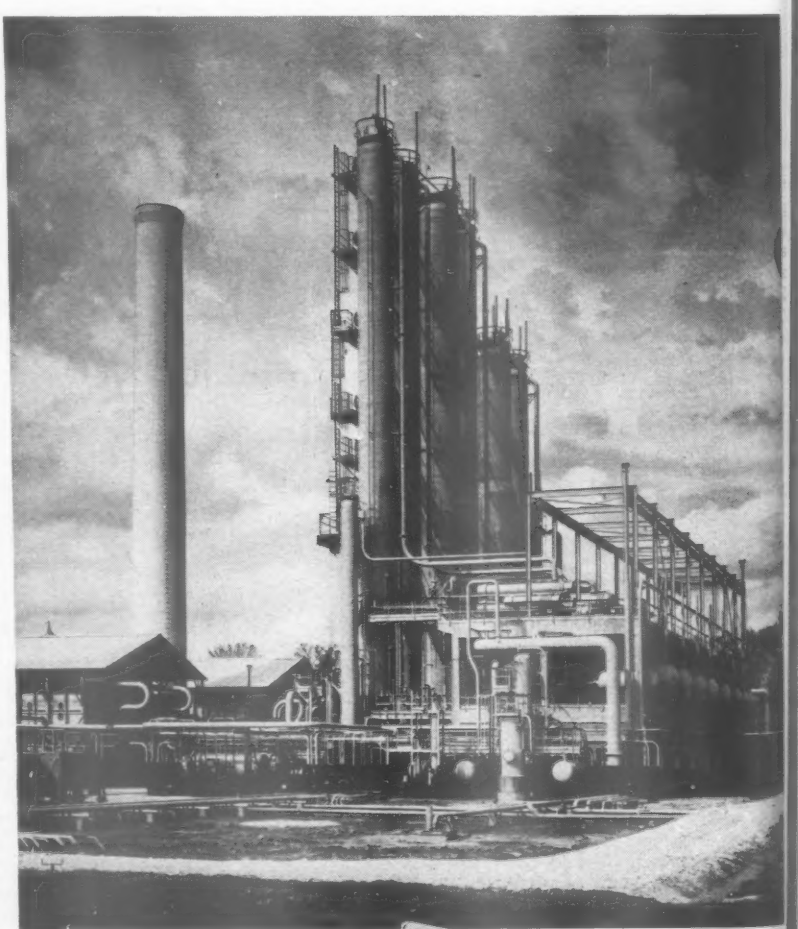
THE recovery and concentration of 350 to 400 bbl. per day of toluene is a major accomplishment at any time, when it is obtained as a by-product of motor fuel produced by thermal cracking. That is what Magnolia Petroleum Co. is doing in the new toluene unit which started operation recently. Answering the call of the armed forces for toluene for explosives and for aviation fuel, this unit is now turning out toluene for military needs, as are several other units built for the same purpose. The process utilized at Magnolia's Beaumont, Tex., refinery is unique in that it employs an azeotropic distillation process developed by Socony-Vacuum Oil Co., Inc.'s general laboratories.

The recovery process includes three main steps: Preparation of a toluene concentrate with a boiling range of 215° to 245° F., concentration of this cut to toluene of 98 per cent purity by azeotropic distillation with methyl alcohol, and the purification of the 98 per cent toluene by means of acid treating and rerunning to produce nitration or aviation-grade toluene. The unit proper includes two pairs of fractionating towers providing two parallel systems for the preparation of the toluene concentrate, two tandem azeotropic towers for distillation with methyl alcohol, alcohol extractor and recovery towers, acid treating and caustic-washing unit, and a toluene rerun tower. The majority of the heat supply is obtained by continuous circulation of a gas oil heat transfer stock through two double, gas-fired furnaces and through various reboilers and preheaters at the towers. A simplified flow diagram shows the various operations and their sequence in the process.

Considerable Toluene

A study of various streams at the refinery revealed considerable quantities of toluene in thermally and catalytically cracked gasolines. Since the toluene in the catalytic streams is being retained in finished aviation gasoline, the feed at the present time is being restricted to the thermal distillates which are incorporated in motor gasoline. The thermal streams available consist of polyform, Cross still, and combination unit naphthas.

The cracked distillate is introduced into the system by being pumped to either of the double fractionator units. The raw charge is divided into three fractions in these towers, a light overhead of about 200° F., end point, a toluene concentrate boiling from 215° to 245° F., and a heavy toluene-free bottoms. The preparation towers on the left are both 7 ft. in diameter and contain 50 trays each,



Magnolia's toluene plant. Double furnaces, left, and fractionators, center

while the next two towers are respectively 8 and 9½ ft. in diameter, also containing 50 trays. Illustrative sets of operating conditions are: Operating pressure at 50 p.s.i.g., a bottom temperature of 352°F. on the first tower with a top at 261° F., and a bottom temperature of 390° F. on the second tower with a top at 327° F. The light overhead from the first tower and the heavy naphtha bottoms from the second tower are returned to the refinery for incorporation in motor fuel. The toluene concentrate from polyform distillate contains about 23 per cent toluene, and a similar cut from the Cross and combination unit naphthas contains about 8 per cent toluene. These toluene concentrates are the charge stocks for the azeotropic distillation step and are accumulated in available intermediate storage tanks.

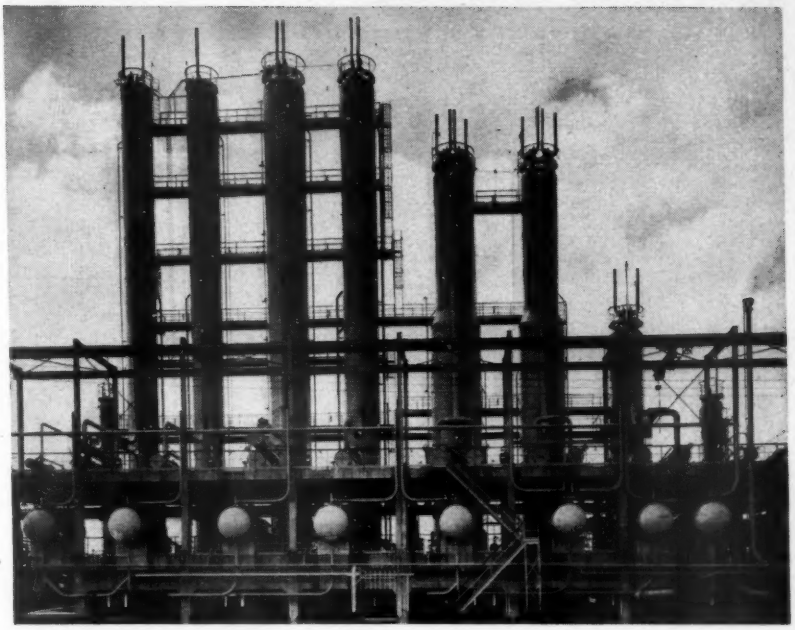
Toluene Fractions

The toluene fractions are mixed with the proper proportions of methyl alcohol and charged to the first azeotropic tower to produce a bottoms toluene product of 50-70 per cent purity. The azeotropic overhead composition is essentially constant, being about 55 per cent alcohol. The 50-70 per cent toluene bottoms is mixed with additional alcohol and charged to the second tower to produce a 96-98 per cent toluene bottoms product. The overhead composition of this tower is approximately 69 per cent alcohol. The two tandem towers contain 36 trays each and operate at 30 p.s.i.g. The first tower operates at a bottom temperature of 300° F. and a top of 195° F., while the second has a bottoms at 305° F. and a top at 200° F. The major advantage of azeotropic distillation is the fact that a relatively small number of trays is required to separate the toluene from other hydrocarbons boiling at the same boiling point or within a few degrees of the aromatic, an operation impossible with straight distillation even with an infinite number of trays.

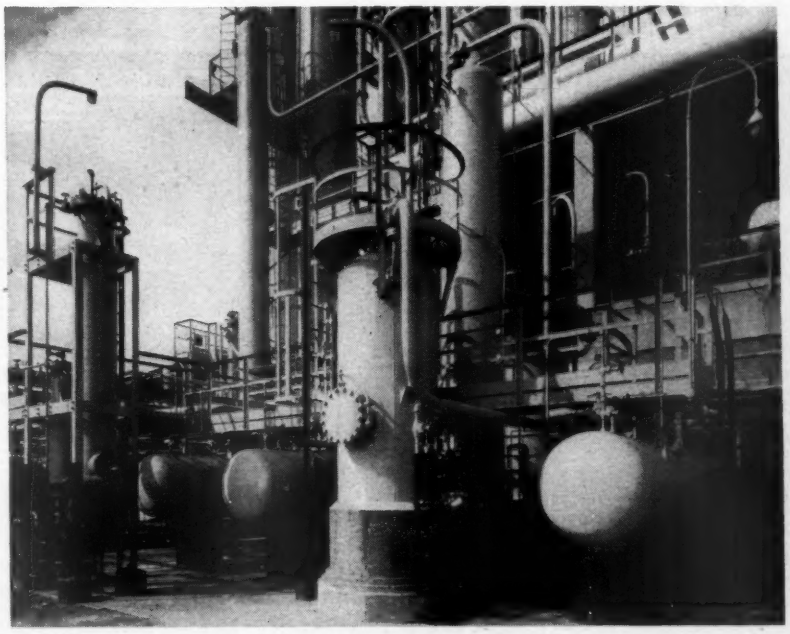
The methanol in the azeotropic overheads is recovered by countercurrent extraction with water in a Raschig-ring packed 5-ft.-diameter tower. The alcohol-free gasoline is returned to the refinery for motor-gasoline blending. The bottoms of water and alcohol containing approximately 31 per cent water is then charged to the 20-tray alcohol recovery tower, where it is fractionated to produce a 99.5 per cent alcohol overhead product and a 99.0 per cent water bottoms. The water is recycled to the extractor and the alcohol goes to azeotropic charge. The separation is carried out at 5 p.s.i.g. pressure with the bottoms at 225° F. and the top at 160° F.

The bottoms of the second azeotropic tower is transferred to the acid treater where it is contacted with 98 per cent sulfuric acid through Duriron nozzles in a two-stage countercurrent treat. A treat of 6-10 lb. per barrel is required in producing an aviation-grade toluene. The separated acid oil is filtered through a gravel-packed tower acting as a coagulator, water-washed in a Raschig-ring packed tower, neutralized with caustic, and again passed through a gravel-bed coagulator. This sequence of coagulation and water washing is used to avoid the formation of any emulsions in the neutralization step.

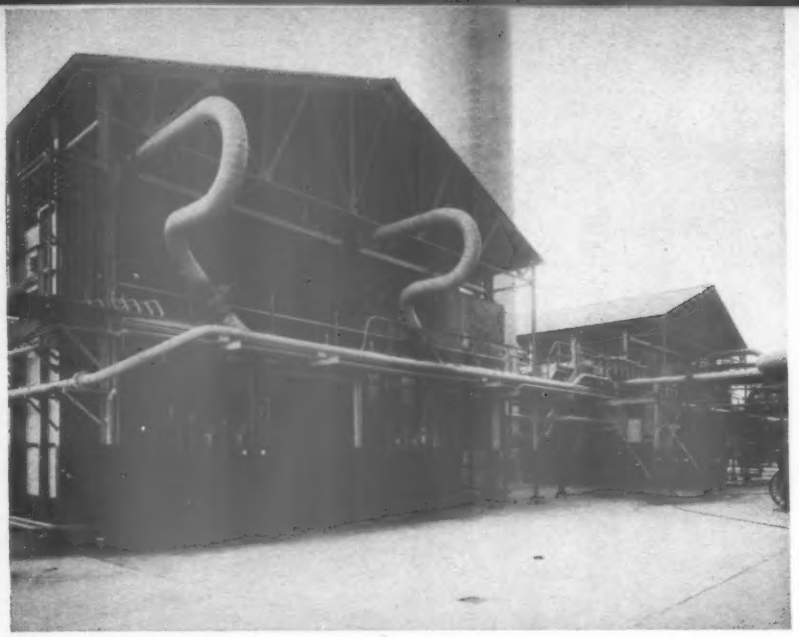
Before rerunning the treated toluene to remove the polymers formed in the acid treatment, the stock is hydrolyzed with 20° Be. caustic at 300°-325° F. with about 1 hour of contact time. The hydrolysis of any traces of sulfates and sulfonates present in the neutralized toluene eliminates



Fractionator battery at Magnolia's toluene plant. First and second towers, first preparation; third and fourth, second preparation; fifth and sixth, azeotropic towers, and seventh and eighth, methanol towers



Acid-caustic treating unit at Magnolia's toluene plant



Twin-coil, double-fired heaters, at Magnolia's toluene plant

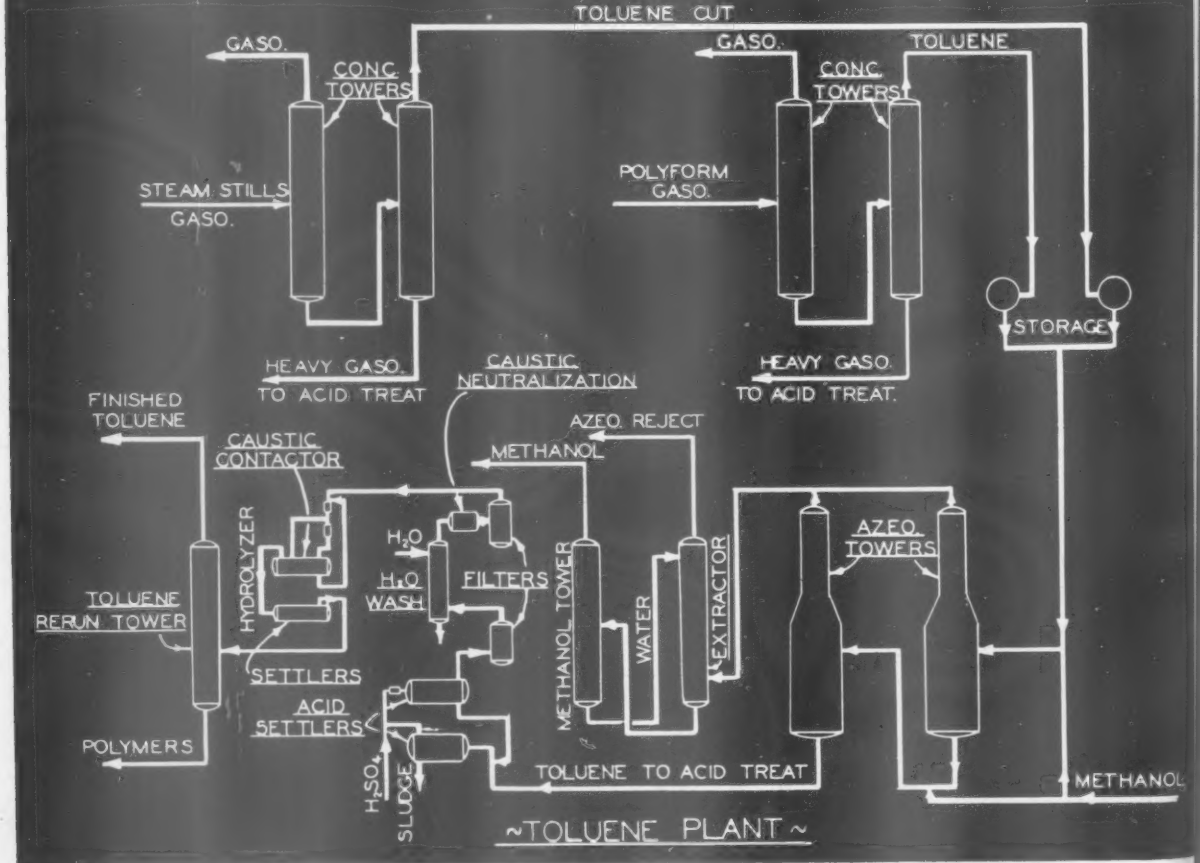
the breakdown of such compounds in the rerun tower reboiler which leads to the liberation of acidic components and high corrosion rates. The rerun tower is 3 ft. in diameter, and operates at atmospheric pressure with a top temperature of 231° F. and a bottoms of 260° F.

Nitration-grade toluene produced at this plant had the following tests: Paraffin content, 0.5 per cent; distillation range, 110.4°-110.8° C.; specific gravity, 0.869; cloud, below 30°C.; "acid wash" color, 1-2. Typical inspections of aviation-grade toluene are as follows: Gravity, 31.6° A.P.I.; Saybolt color, 30 F.; sulfur, 0.03 per cent; copper dish gum, 2.5 mg/100 ml; copper dish corrosion, none; accelerated gum, 4 mg/100 ml; accelerated gum residue, 0.1 gms/100 ml; A.S.T.M. distillation range, 227°-233° F.

By this process about 80 per cent of the toluene present in the raw stock is recovered as a finished product. The losses are distributed largely in the azeotropic overhead and in the acid-treating and rerunning steps.

The furnaces used to supply heat to the unit through a gas oil medium are capable of 180,000,000 B.t.u. per hour total duty. Each of the two furnaces possesses two radiant sections fired at each end with five burners. The heat transfer oil splits into four parallel streams to the furnaces which are recombined at the outlets. The heating oil is an acid-treated stock with a low "characterization factor," 10.8, an A.S.T.M. initial boiling point of 470° F. and 94 per cent over at 700° F. The oil enters the furnace at 390° F. and leaves at 600° F. Inspection data shows little if any change in the heating oil properties up to the present time.

Simplified flowchart of toluene recovery process. Note three main steps: feed stock concentration in two parts; azeotrope formation and distillation; recovery of azeotrope-forming methyl alcohol for reuse



Gasoline Consumption as Related to The Postwar National Economy

*by R. W. Reinhart**

Total gasoline demand for the United States in 1945 will be practically 600,000,000 bbl. including aviation fuel, this author estimates. For 1949 the estimate is 755,500,000 bbl., reflecting normal consumption increase plus relaxation or removal of rationing, etc.

POSTWAR planning to our company is in principle no more than the continuation of past policies of forward planning at every stage in the activity of producing, manufacturing, and distributing petroleum products. However, there is an important difference in the direction and details and perhaps in the sphere of our planning for the period following this war.

In selecting a basis for our estimates of gasoline consumption as presented in this article, we have considered it as a part of the larger problem of attempting to evaluate the responsibilities of our industry to the national economy.

The structure of our economy has been under close scrutiny by a wide variety and by large groups of our citizens during and since the depression years of 1932 and 1933. It appears to our sales research group, as it undoubtedly does to many others, that some fundamental changes in our economy are inevitable in the next generation.

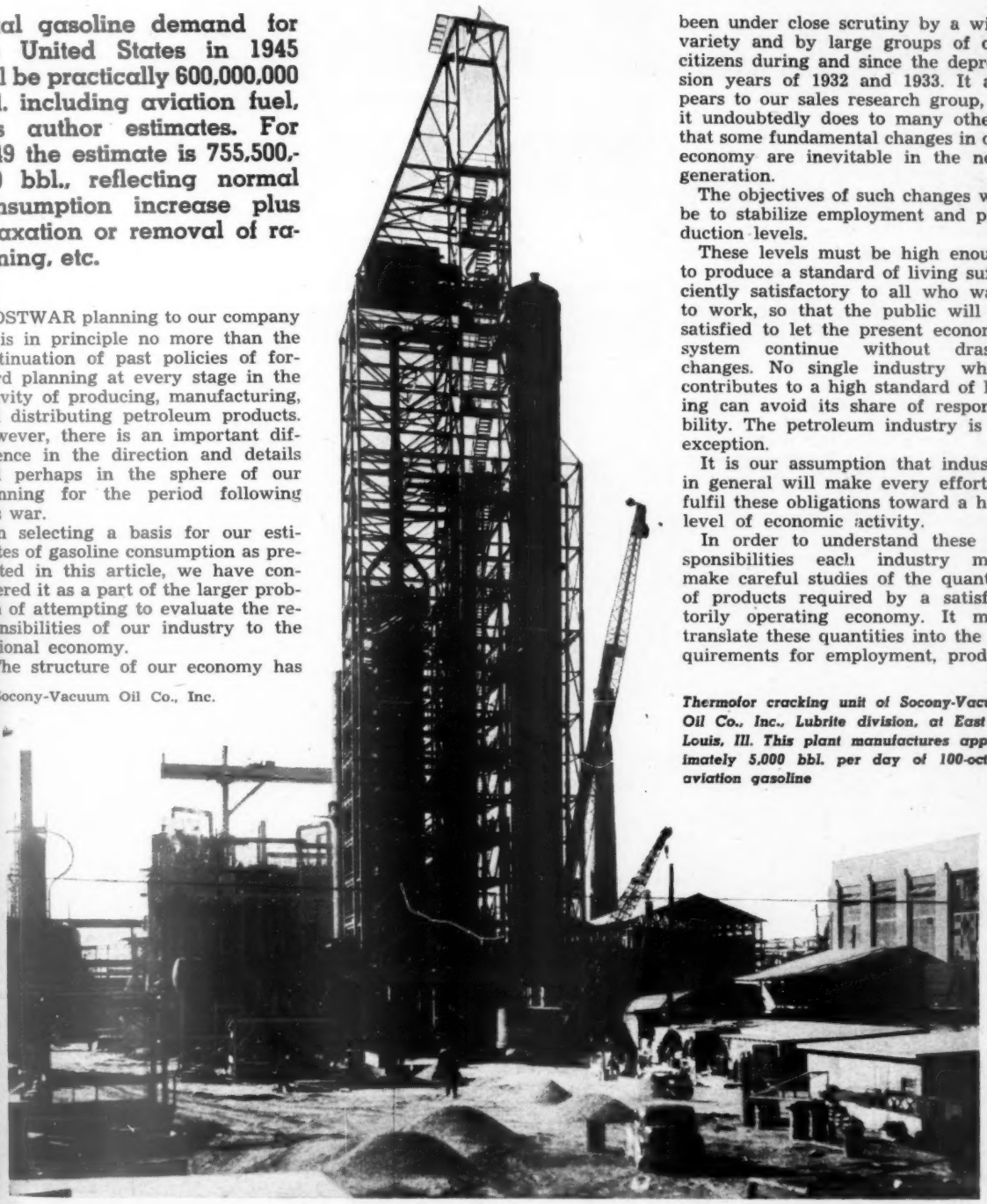
The objectives of such changes will be to stabilize employment and production levels.

These levels must be high enough to produce a standard of living sufficiently satisfactory to all who want to work, so that the public will be satisfied to let the present economic system continue without drastic changes. No single industry which contributes to a high standard of living can avoid its share of responsibility. The petroleum industry is no exception.

It is our assumption that industry in general will make every effort to fulfil these obligations toward a high level of economic activity.

In order to understand these responsibilities each industry must make careful studies of the quantity of products required by a satisfactorily operating economy. It must translate these quantities into the requirements for employment, produc-

*Socony-Vacuum Oil Co., Inc.



Thermofor cracking unit of Socony-Vacuum Oil Co., Inc., Lubrite division, at East St. Louis, Ill. This plant manufactures approximately 5,000 bbl. per day of 100-octane aviation gasoline

tive facilities, wages, costs, profits, prices, distribution facilities and organizational structures, and other factors for the industry.

These studies should be widely discussed and understood within industry in general if good results are to be gained in the form of policies which will keep the control of the economy in the hands of those who know most about the practical operation of the economic system.

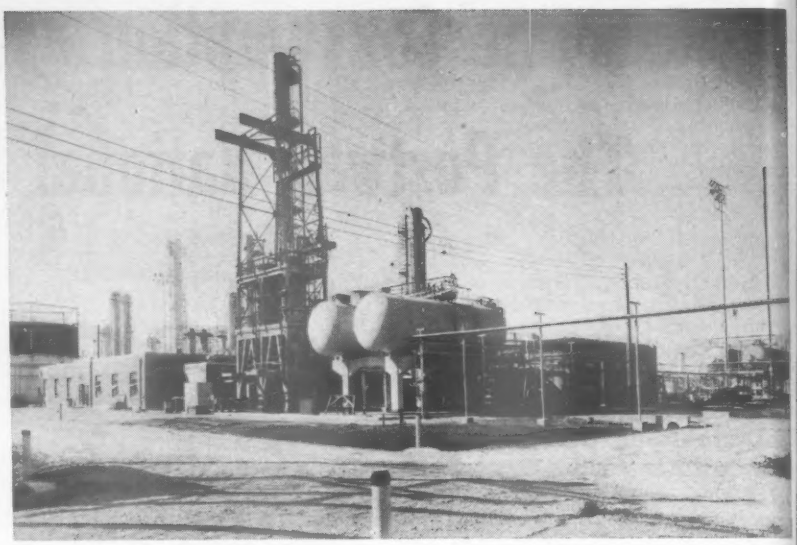
Our approach to the problem of estimating postwar demands for gasoline was to relate these demands to such national economic factors as employment, income, and production.

Assumptions Underlying Gasoline Estimates

There are so many factors which have an influence on gasoline consumption that the analyst is forced to put down certain basic assumptions under which his estimates of postwar demand may be expected to materialize. The more important assumptions which we made in estimating the demand for gasoline in the 5 years immediately following the war are as follows:

1. The European war will be ended in the latter part of 1944 and the war in the Pacific will continue for 1 or 2 years more.

2. Gasoline rationing will be continued after the war's end, until such time as readjustments necessary to producing gasoline for civilian needs can be made at refineries, say, 6 months after cessation of hostilities, either in the European or the Pacific area.



Hydrofluoric acid alkylation plant of White Eagle division of Socony-Vacuum Oil Co., Inc., at Augusta, Kans.

3. The production of tires will not be a serious limiting factor in the consumption of gasoline immediately after the war.

4. It is expected that the production of new passenger cars will get under way within 6 months of the end of the war in Europe and reach a peak of production during the third year following the war. This rate of production, it is expected, will taper off to a normal production within the next 2 years.

5. Technological improvements as they affect total gasoline consumption will not be effective in an important way until the fifth year after the war.

6. The normal relationships of gasoline consumption to such economic factors as income payments and industrial production are expected to continue as they were for the 13-year period preceding this war. It has been assumed that the improvements in incomes for the lower-income groups and that the expansion in public

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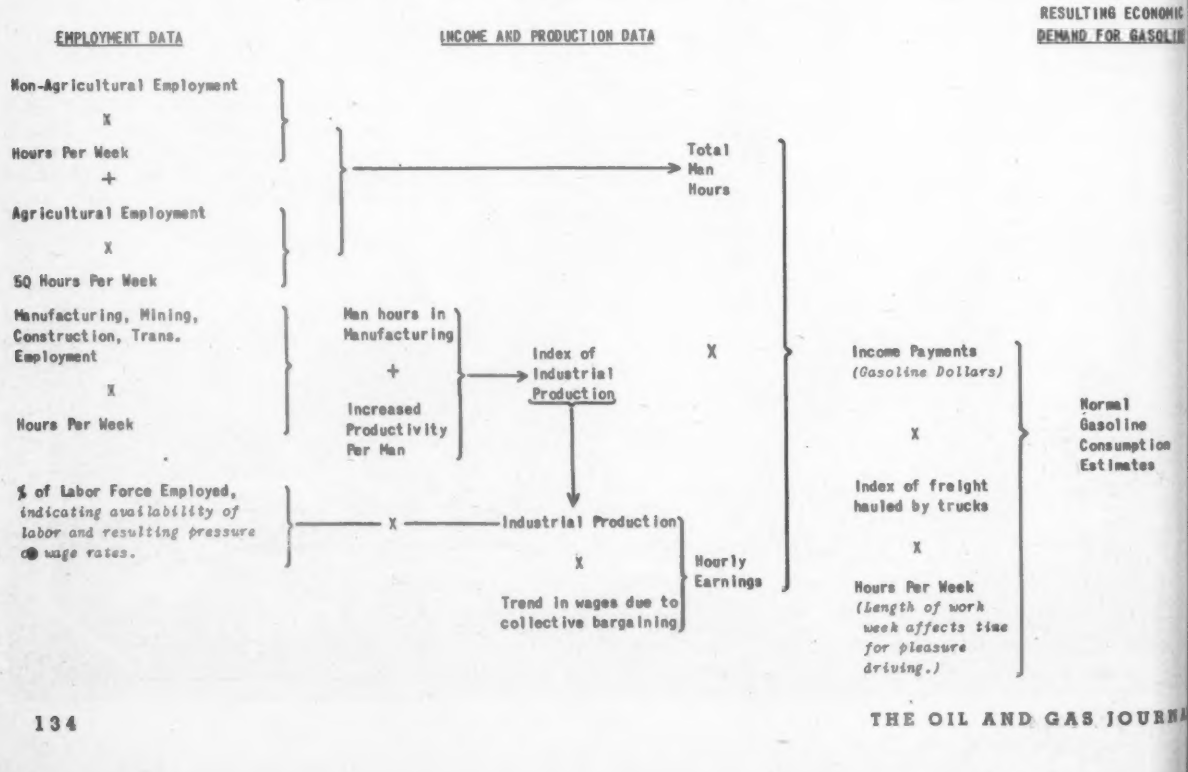
FIG. 1: RELATIONSHIP OF EMPLOYMENT DATA TO GASOLINE CONSUMPTION



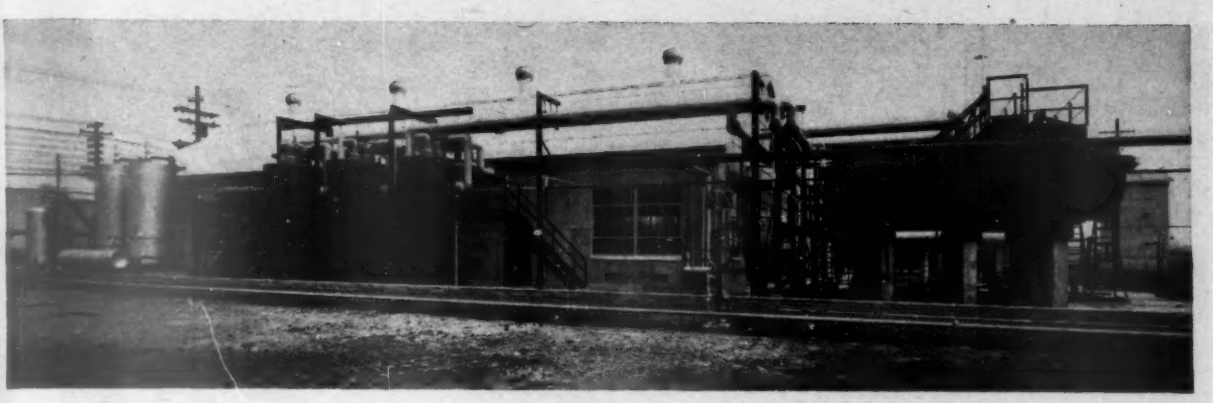


Fig. 1—Stratcold treating plant, side view

Acid Treating at Low Temperature Solves Many High-Sulfur Fuel Problems

by J. A. Altshuler*

FOR many years sulfur removal from hydrocarbon distillates, straightrun or cracked, has been one of the petroleum industry's annoying problems. It has been troublesome because it usually has implied use of sulfuric acid as a chemical agent for the removal of the sulfur. Some refiners have avoided such chemical treatment owing to the secondary problems of acid handling, regeneration and disposal. Nevertheless, sulfuric-acid treatment of distillates has for years been widely employed in many refineries for sulfur and gum reduction. Moreover, in recent years improvements in acid handling and acid-recovery methods have eliminated most of the formerly objectionable features accompanying such treatment.

Today the limitations of crude-oil supply and the demands of war have imposed new problems on the refiner, problems which can again be solved by the time-proven controlled-temperature treatment with sulfuric acid. First, the shortage of crude oil is making necessary the use of more and more high sulfur-bearing crudes, such as West Texas. Although sulfur specifications have been somewhat liberalized, many refiners are approaching the point where sulfur removal from some of their cracked gasolines becomes necessary to maintain refinery sulfur and blending balances.

Secondly, and of major importance currently, is the problem of catalytic

*Stratford Engineering Corp.

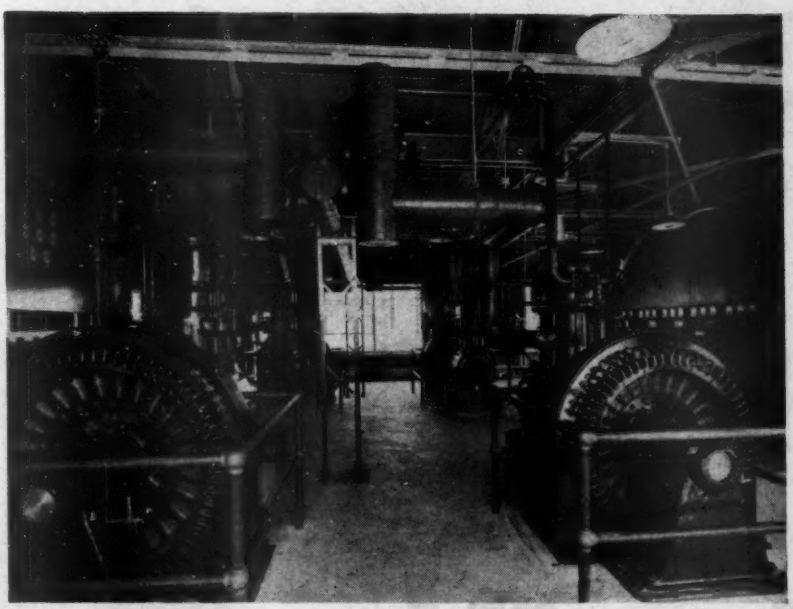
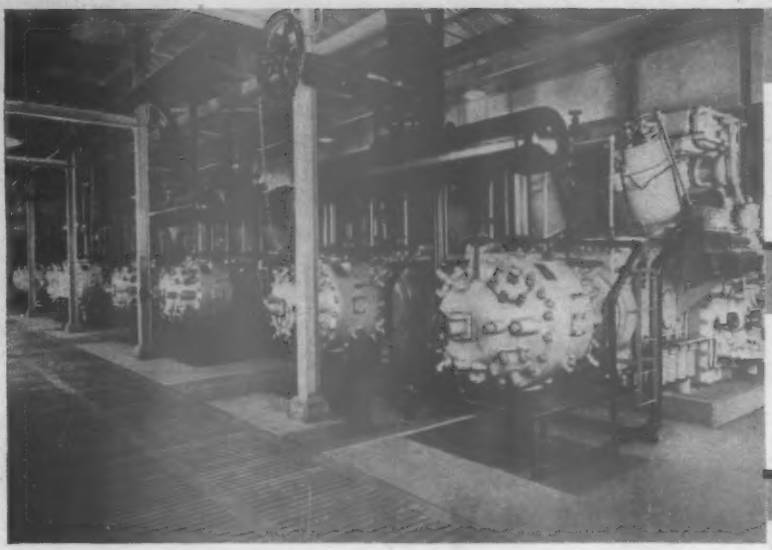


Fig. 2—Ammonia refrigeration installation

Graduated in petroleum engineering from University of Pittsburgh in 1923, "Joe" Altshuler joined Associated Oil Co., San Francisco, and worked in refinery engineering and development until 1928 when he affiliated with Stratford Engineering Co., Kansas City, in general refinery engineering which included the construction of a refinery in Ploesti, Rumania. From 1932 to 1934 he was technical director for Alco Products Co.'s foreign subsidiary with headquarters in Paris. Returning to America early in 1935 he became vice president of Stratford Engineering Corp., a position which he now occupies.



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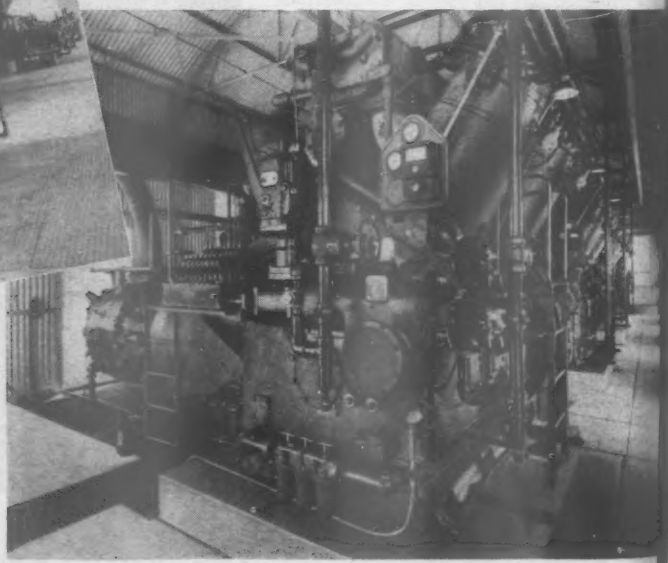
DEPENDABILITY— always the assurance of continuous compressor performance from the first minute "on stream" until the completion of the run.



TYPE G-MV ANGLE Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.

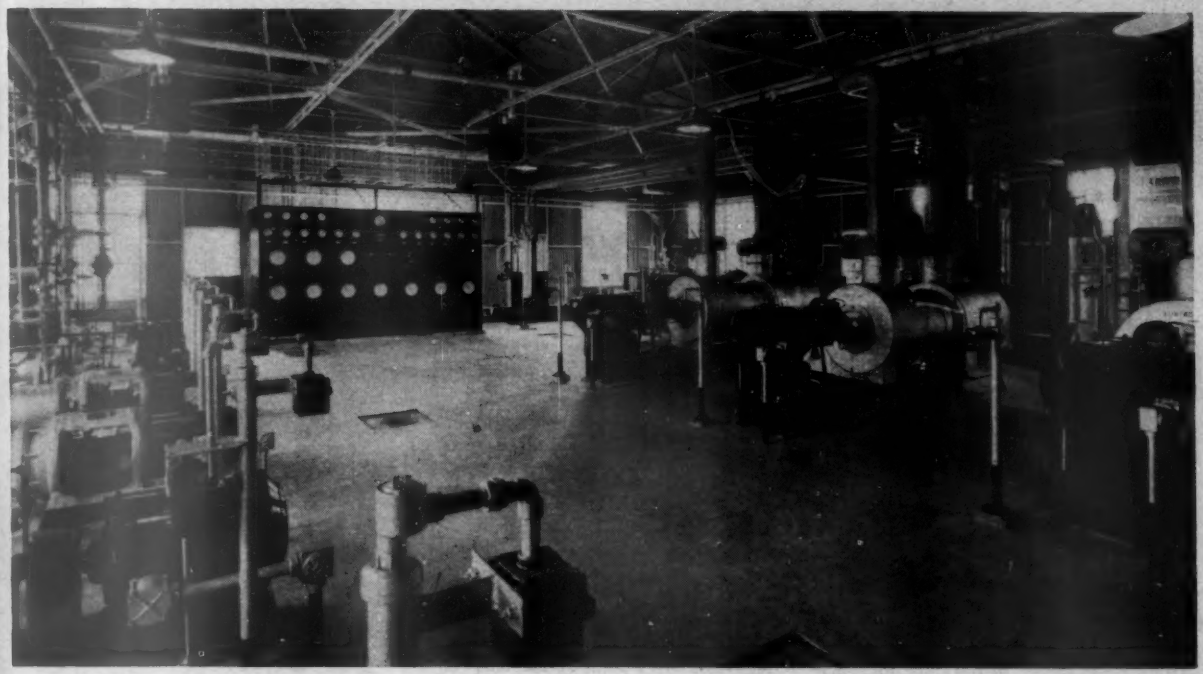


Fig. 3—Treating and control room

gasolines which contain too large a percentage of olefins or sulfur to permit their use as a component of aviation fuels. Confronted with this problem, there are several courses which can be selected. Some are as follows: (1) Hydrogenation; (2) second-pass catalytic treatment; (3) alkylation and (4) acid treatment.

Hydrogenation. — This process is costly in capital investment, time for construction, critical materials and operating expense.

Second-pass catalytic treatment.— This solution requires either duplication of catalytic-cracking facilities with the same disadvantages as to capital investment and use of critical materials as hydrogenation, or reduction of throughput capacity when a single-pass catalytic unit only is available. This is hard to reconcile when aviation gasoline is so urgently needed for the war effort.

Alkylation.—A portion of the catalytic gasoline, particularly that having a boiling range of approximately 120°-220° F., may be used as an alkylation feed stock. This, of course, involves availability of isobutane for the alkylation and alkylation plant capacity. If C_4 and C_5 olefins are available, then they should be alkylated ahead of the light-catalytic fraction as they make a higher yield of better product. Light catalytic gasoline may then be used as an akylation-feed stock up to the limit of available isobutane.

Acid treatment.—Catalytic or thermal gasolines may be acid treated with sulfuric acid for olefin removal to the point where the stock may be used in aviation blends. The degree of treatment required depends on the over-all blending schedule in the operations of any particular refinery. However, in most cases the light-catalytic fraction will contain a high percentage of olefins which normally must be reduced materially in order not to adversely affect the final aviation blend. If sulfuric acid is used for this olefin removal and if the treatment is carried on at atmospheric temperature, without temperature control, over-all losses encountered are high and are extremely wasteful of potential aviation-blending stock and chemicals.

If sulfur-bearing naphthas result from thermal cracking or from single-pass catalytic cracking and it is necessary to reduce the sulfur therein, then acid treatment solves either the problem of sulfur reduction alone or the combined problem of sulfur reduction and olefin removal. In the case of sulfur reduction only for use in motor gasoline, uncontrolled temperature treating is usually extremely wasteful and expensive and when the treatment is for the dual purpose, as in the case of aviation blending stocks, the seriousness of the problem is further emphasized.

In cases where sulfuric-acid alkylation is employed, obviously spent alkylation acid can be used either for one or both of the above treating operations thus providing dual usage of the acid before regeneration.

Since sulfuric acid treatment is indicated in cases where (1) no hydrogenation or catalytic treating are provided for olefin removal; (2) desulfurization of cracked gasoline is required, and where (3) alkylation is not practicable owing to unavailability of isobutane of C_4 and C_5 olefins are in excess.

Then the results of uncontrolled treatment at atmospheric temperature must be considered. The acid requirements being relatively high, the temperature to which the mixture rises is above the critical temperature of acid sludge. This being the case, SO_2 is evolved which very often results in sulfonation of distillate being treated with subsequent lack of sulfur control. The effective treating strength of the acid is reduced because of this SO_2 evolution, thereby increasing the amount of acid required for a required treating result. The use of higher acid rates results in increased losses, both solution and polymerization, as well as loss of octane number.

Figs. 1, 2, and 3 show a typical Stratcold acid-treating plant which was originally installed for removal of sulfur from high-sulfur cracked naphthas. Such a plant includes precaustic washing, three stages of acid treatment at low controlled temperatures between 20° F. and 40° F., clarification for removal of "pepper sludge," two stages of water washing and caustic neutralization.

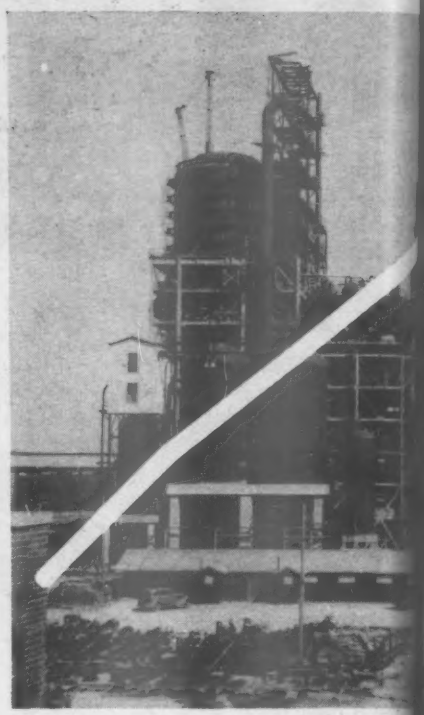
These plants are equipped with mechanical refrigeration for absorption of heat of reaction and maintenance of desired treating temperature.

The entire process, as typified by these photographs, is automatic in its operation and requires only supervisory personnel.

Although the plant shown was originally designed and constructed for sulfur removal, it represents the same type of installation now recommended for olefin removal or combined olefin and sulfur removal from catalytic gasolines. Thus a previously developed and well-known process can be adapted to solving some of the problems with which many refiners find themselves confronted in this day of rapidly developing petroleum technology.

Technology's Part in the Aviation Gasoline Program

*by Robert G. Cragin**



MUCH has been said and much more should be said in praise of the technological genius of the petroleum industry. Before Pearl Harbor the industry produced and the planes of the United Nations consumed less than 45,000 bbl. per day of 100-octane aviation gasoline. Today the petroleum industry of the United States is producing more than six times this amount of a higher quality gasoline which will permit 20 per cent increase in aircraft engine power output. Behind this enormous increase in production there lies a story—a story which even today cannot be told in its entirety—but which is a tribute to the inventiveness and determination of our petroleum technologists.

Before Pearl Harbor there were 14 catalytic-cracking units operated almost entirely for the production of motor gasoline. In January 1942 the first of these was converted to the manufacture of high-grade aviation gasoline. By August of that year all but one of the prewar catalytic-cracking units had been converted and today every catalytic-cracking unit in the country is operated to make the maximum contribution to the aviation program. Also before Pearl Harbor there were 76 catalytic polymerization units operated for the most part to produce high-quality gasoline. By December 1942 34 units were producing codimer which was converted to high-quality blending agent in existing hydrogenation equipment. Today every unit capable of conversion is producing codimer. The technical talent of the industry marshaled through the codimer subcommittee of the Aviation Gasoline Advisory Committee and the synthesis subcommittee of the Technical Advisory Committee of PIWC, have been in constant touch with the operating plants to insure that all possible steps are taken to achieve maximum production. Conversion of these two types of catalytic units has been responsible for 17.2 per cent of the total increase in production since Pearl Harbor.

During the latter months of 1941 our air forces recognized the need for improved rich-mixture performance and in January 1942 requested that by the end of that year a fuel of 130 performance number be supplied. At the same time the research organizations of two companies independently discussed with the petroleum administration the possibilities of producing cumene. By March of that year pilot-plant operation had demonstrated the feasibility of cumene production and by May the first cumene plant was placed in operation. Through close cooperation of the various companies involved and complete interchange of technical information the program was rapidly expanded to provide sufficient cumene capacity to consume all surplus benzol production. By August 1942 eight plants were in operation and by October the industry had met the challenge inherent in the air forces' request for 130 performance number fuel. The specification became effective January 1, 1943, and at the same time the cumene plants contributed to increase production by 17.2 per cent of that obtained since Pearl Harbor.

Two Committees Formed

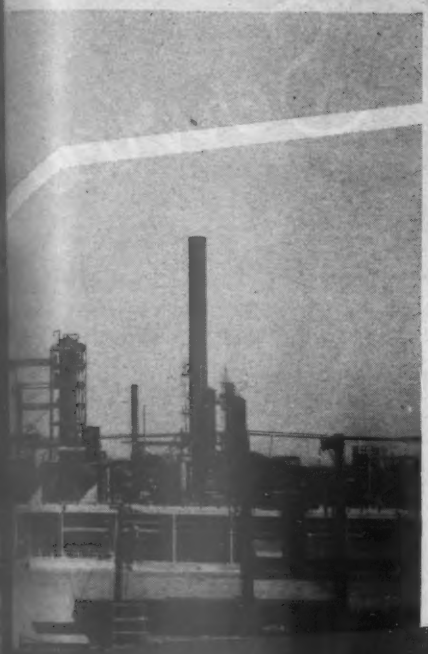
The technical skill of the petroleum industry was formally organized during the latter part of 1942 into two national committees, the Aviation Gasoline Advisory Committee which concerns itself with all possible means of achieving maximum production of aviation gasoline, and the technical advisory committee through which the research organizations of the petroleum industry have been mobilized for war.

Since that time these two committees through their subcommittees have recorded an impressive list of achievements. The AGAC has followed the operations of all aviation-gasoline plants from the standpoint of raw-material requirements and utilization and has assisted the petroleum administration in maximizing production through the most efficient use of aviation components without regard to production source. The TAC in an advisory capacity both to PAW and to AGAC directly has contributed to this program enormously by correlation of fundamental data and by carrying out research work through its member companies for the benefit of AGAC and the industry at large. A very substantial portion of the increase in aviation production and quality may be credited to the tireless work of these committees and their subcommittees.

In the last analysis no such enormous increase in aviation-gasoline production could have been achieved without the installation of new facilities. The aviation-gasoline program will include when completed 126 refineries producing 100-octane gasoline or major components. The facilities installed will represent a capital expenditure of over $800,000,000 of which approximately $200,000,000 represents direct government financing. They will include 90 catalytic-cracking plants of four different types of design. Only one of these processes had a background of prewar operation. These facilities also include 69 alkylation units, 35 butane isomerization units, 2 butane dehydrogenation units, 2 neohexane plants and 1 plant for the manufacture of diisopropyl, all of which are recently developed processes. Hydroforming, sulfuric-acid treating and hydrogenation also form a vital portion of the program. The record of technical men in bringing these plants into operation has been one of which they may be proud.

No historical statement of aviation-gasoline production is complete without the qualification that we are today producing only a part of the aviation gasoline that will be required by June and a smaller part of that which will be required by the end of the year. The next few months are the most critical of all and will require the most exacting use of our technical manpower.

*Assistant director of refining, Petroleum Administration for War.



The most accurate projection of an industry's problems is obtainable from the experience of its informed executives and technologists—the men responsible for charting its course. On these pages and several pages which follow, leaders in construction, operation and research summarize their viewpoints of the present and postwar outlook for petroleum manufacture, and state what they feel must be done to insure a healthy industry.

REFINERS CHART COURSE

Trained Manpower, More Flexible Transportation Are Current Needs

By C. B. Watson
Vice president, The Pure Oil Co.

TWO outstanding needs of the refining industry, at the moment, are better sources of supply for manpower to operate and maintain the many modern units that have been introduced during the war period in most refineries, and the more permanent and flexible allocation of the transportation facilities.

A great deal of worth-while production of various products has been lost in the last few months because of the inability of refining operations to establish, over reasonably long periods, an operating schedule which will enable them to operate at highest efficiency. After the war, plants will be able to operate consistently for the manufacture of the products which each refinery can make to the greatest advantage and, we believe, the efficiency of the average of the American unit will be tremendously increased when this condition is brought about.

Industrial relationship should improve materially when thousands of men become available for refinery work. The tendency to call a strike for unimportant reasons will, we believe, disappear. However, the inequalities of the present labor legislation will have to be rectified if proper industrial relations are to ever come back to the refining industry.

We believe that petrochemistry is only in its infancy. The production of such products as synthetic rubber, brought about through dire necessity, is only one example of the many important products that will be made available by the refining industry in the years immediately succeeding the end of the war.

Fundamentally, research, in our opinion, will be stepped up by all the important refiners in the industry, but until the present attitude of the Government in connection with the patent situation is changed, research will be unable to produce the results which it otherwise could contribute to the welfare of this country.

We believe that products with overlapping specifications will be replaced with all-purpose material in aviation products, automotive products and greases. We believe that the use of catalytic and thermo-cracking will be expanded and that neither type will supersede the other.

Expansion Into Synthetics Is Outstanding Achievement

By M. W. Boyer

Vice president and general manager, Standard Oil Co. of Louisiana

THE most outstanding development in the petroleum industry in recent years has been the expansion into the synthetic field. From an industry devoted primarily to purifying products supplied by nature it has become an industry that makes many of its own products from petroleum raw materials. In almost all of the processes for doing so catalysts are employed.

The new, revolutionary processes have only begun to be applied. Polymerization is not a new reaction, but in petroleum it was intended to produce sludges that could be discarded. By suitable choices of catalysts the reaction has been made to produce valuable liquid products from waste gases. Specific gases can now be polymerized to liquids that can be hydrogenated to gasoline components of

For Distinguished Service

WARREN'S STABILIZED NATURAL GASOLINE

Hundreds of Allied fliers have won high military honors for distinguished service in the air corps. We are very proud of the fact that much of the 100 Octane Aviation Gasoline that carried these heroes of the United Nations over the islands of the South Pacific and the Aleutians, the continents of Africa and Europe, was made possible through the use of Warren's Stabilized Natural Gasoline and Chemical Grade* Iso-Butane, Normal Butane and Iso-Pentane which we have been able and privileged to supply to the refineries of the nation. Warren's Stabilized Natural Gasoline is also supplying the elements of quick starting, power and speed, essential to the motor fuel used in the motorized equipment for military, industrial and transportation needs.

Chemical Gra
HYDROCARBO
Iso-Pentane
Normal Buta
Iso-Butane
Propane

WARREN PETROLEUM CORPORATION

Manufacturers, Exporters and Marketers of Natural Gasoline and Liquefied Petroleum Gas

Tulsa, Oklahoma

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La., and Marcus Hook, Pa

higher octane ratings than those of naturally occurring hydrocarbons. Similarly, alkylation and isomerization have, within a few years, been adapted from the laboratory to regular refinery synthetic methods and catalytic cracking has greatly extended the usefulness of petroleum products to the manufacture of high-octane gasoline. At the same time the petroleum industry has originated and developed on a large scale the production of butadiene and synthetic nitration-grade toluene.

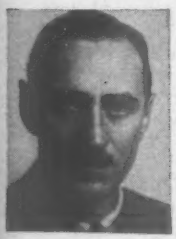
The rapid growth of all these processes suggests that the petroleum industry is on the eve of a new era. Catalytic synthetic processes will assume a prominent place in the production of peacetime products. A whole new field has been opened up of which the end is nowhere in sight.

More Efficient Utilization of Crude Reserves Is Challenge

By J. F. M. Taylor

Vice president in charge of manufacturing, Shell Oil Co., Inc.

THE technological and economic arguments for and against a rapid increase in octane rating of motor fuels, postwar, are quite involved, and usually cannot be separated. The technological field embraces both the ability of refiners to make higher-octane motor fuel and the ability of the automotive industry to produce and market vehicles capable of utilizing efficiently the improved fuel. Economics of the refining processes and the efficiency of the automobile engine and transmission must be considered together, both in the light of competitive conditions and in terms of the national economy so as to insure the most efficient utilization of crude-oil reserves.



The refining industry should be capable of increasing the octane number of motor fuels, postwar as compared to prewar, through utilization of a large part of the equipment now used for production of aviation gasoline and other war products. It has been estimated by Brown and Barnard* that an average increase of three octane numbers could be thus realized. Whether this increase can be justified is quite another question, since it would be possible to achieve the alternative of increasing the yield from a barrel of crude oil while keeping octane constant at the prewar level.

The future road may lead upward to higher-octane heights with narrowing width of yield or may stay on an even octane grade with broadening yield per barrel of crude. In either case, the refiner and the research chemist must still face the challenge of how to effect improvements in "cracking" or molecular rearrangement processes so that either the octane number or the yield, or both, of gasoline may be increased without a disproportionate degradation of other products. It is almost axiomatic, of course, that as more and more energy is consumed in operating the more complicated refining processes, the cost per unit of fuel produced will increase, although we hope not in a direct proportion. The balance will require continual readjustment as better refinery processes and more efficient automotive-propulsion devices are developed, to the end that from the point of view of conservation of natural resources, the common goal of maximum ton-miles of transportation per barrel of crude oil is attained.

*Bruce K. Brown and D. P. Barnard, S.A.E. Journal, Vol. 52, No. 3, Mar. 1944.

Applied Science Will Meet Any Future Problems

By Frank A. Howard

President, Standard Oil Development Co.

THE world looks forward to a standard of living for all peoples comparable to that achieved in the United States, and the United States looks forward to a postwar production level far ahead of the past. For these goals the wide availability of liquid fuels is a necessity. Both producers and refiners have before them a challenge. The war has given them both far greater confidence to face this challenge. This new confidence comes from the proof that the theories of chemical engineering really will work.

Processes such as alkylation, isomerization, superfractionation, catalytic cracking, hydrogenation, dehydrogenation and hydroforming—all regarded as major technical and economic hurdles—have been put into full commercial operation on a sound cost basis. These and other scientific developments no more difficult are not only capable of converting crude oil into higher yields of better products, but also capable of aiding in the discovery and production of more oil, and if need be, in the conversion of coal, shale and natural gas into liquid fuels.

We have been saying for years that applied science would meet any future problems of the oil industry—now we are really convinced.

Emphasis Must Be Placed On Utilization of Byproducts

By M. Halpern

Vice president, The Texas Co.

THE limited availability of crude oil will have a marked effect on refinery operations in the postwar period. In order best to utilize the supply, emphasis should be directed toward the use of processes giving the highest yields of the desired products, and toward the elimination of secondary processing, in which there is a considerable conversion of the material to less readily used byproducts.

There should also be an extension of the established trend toward full utilization of byproducts, such as gases and heavy residua, in manufacturing the principal products through the development of suitable conversion processes.

In order to make more material available for conversion to principal products it may be desirable to eliminate the manufacture and sale of certain materials for which adequate substitutes are obtainable from other natural resources.

The reduction in crude supply will also necessitate increased use of high-sulfur crudes. A change from "sweet" to "sour" crude will, in many refineries, call for changes in construction materials in order to avoid excessive corrosion and to provide suitable processes for finishing the stocks into marketable products.

Operating Expenses Must Undergo General Pruning

By Dr. Clive M. Alexander

Vice President, Aetna Oil Co.

THIS war has brought to the petroleum industry many changes: old processes enlarged and intensified, many inventions of constructions and processes reduced to practice, organizations modified to meet regulations and available manpower, and much cooperative work done between highly competitive companies. All this has resulted in increased operating expenses and large capital investments. The former has been taken care of by compensatory arrangements or increased products values and the lat-

ter, by private or government funds to be amortized as emergency facilities. However, as a whole the industry still prospers and has much to gain in the postwar period by the many emergency changes.

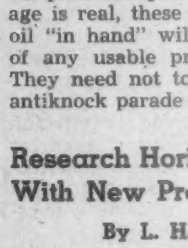
With the war's end many of the emergency constructions, processes and organizations must be revised or discontinued. Although higher product values in the postwar period can be expected, operating expenses will need to be reduced. Present large investments will have to be quickly written off to meet competition of postwar investments in better and more economical processes. As a result the postwar refiner who has not made these large expenditures should be in a satisfactory position. Also if the predicted postwar crude-oil shortage is real, these refiners with crude oil "in hand" will not want for sale of any usable products at a profit. They need not to have followed the antiknock parade and like operations.

Research Horizon Is Bright With New Processes

By L. H. Harvison

Vice president, M. W. Kellogg Co.

IN peacetime alert process development and engineering companies will continue their rapid wartime technical progress.



Better fuels and lubricants for tomorrow's cars and planes will be a a major research project. The uncertain extent of the nation's future oil supply will stimulate widespread investigations of synthetic fuels, and petrochemical research will lead to many new specific compounds derived from the endless mixtures in natural petroleum.

In these activities the fluid-catalyst system, a recognized success in cracking operations, will play a great part. The application of this new technique to broader fields will require improved powder-recovery methods, better understanding of gas-powder chemistry, more fundamental knowledge of gas-powder flow properties, etc. Research will yield new catalysts having longer useful life, increased catalytic activity, and more selective action in preventing unwanted side reactions.

Process development will be speeded by mass spectrographs, X-ray diffraction units and other new laboratory tools. Improved pilot plants will furnish more significant data for analysis and correlation by more exact mathematical methods. Statistical mechanics and probability calculus will become essential aids to advanced workers in practical engineering sciences.

The research horizon is bright—with new processes and new products—cheaper, better and more abundant.

Application of Catalytic Methods Will Expand

By Eugene J. Houdry

President, Houdry Corp.

THERE is evidence that the application of catalytic methods to processing of petroleum derivatives will continue to expand. For many years we have maintained that catalytic-cracking plants would handle whole crude bottoms to make, without production or rejection of tar, high-quality motor fuel in high yield, as well as distillate fuel meeting market specification. This is now becoming practical and the motor fuel is not only exceptional in quality but its yield is even higher than anticipated.

Catalytic cracking will be applied to all fractions of the crude and continue to make refinery operation more flexible. Byproduct gas from catalytic operation will be a valuable source of additional gasoline or of raw material for chemicals manufacture.

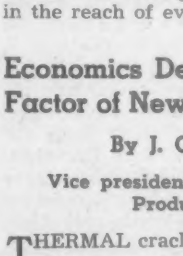
Advances in design and processing methods will bring capacities, investment and operating costs of catalytic crackers to even greater extent within the reach of every refiner.

Economics Determining Factor of Newer Processes

By J. G. Alther

Vice president, Universal Oil Products Co.

THERMAL cracking, within the past few years, has given commercial birth to a "catalytic cracker." This youngster has been called upon to perform a man's job before reaching maturity. Its performance is amazing in producing vital war products even though costs are considered excessive by peacetime standards. While catalytic cracking may be here to stay, the extent of its utility in peacetime will depend upon the cost and demand for this type of gasoline. Economics will determine its place among other competing processes. Moreover, intensive research and commercial development will have to continue for many years before catalytic cracking will replace thermal cracking. Having pioneered in both the thermal and catalytic cracking arts, we can safely predict that the thermal cracking process will continue to be essential even though it may have to take second place in the future. Thermal cracking facilities will be taxed to the limit for several years after the war to meet the large demand for good motor fuel.



The many small refiners who do not have the present high-cost "cats" need not be unduly concerned about their future—low-cost processes will be available at the proper time.

Single Authority Needed for Research and Manufacturing

By J. W. Vaiden

Vice president of manufacturing, Skelly Oil Co.

TECHNICAL progress of today is moving at too fast a pace for even one group within a company to keep up with the progress of another group; however, improved correlation between research and manufacturing departments can be achieved through three main policies—placing both departments under a single top authority to insure their working toward common ends; increased use of interdepartmental committees with regular meetings and progress reports; and a program for interchange of personnel between the two departments.

A single authority controlling both manufacturing and research will insure a forward-looking program which will be progressive enough to keep products competitive, and practical enough to be of real value in solving problems of production.

Interdepartmental committees judiciously used can keep progress reports truly current while avoiding the danger of taking time of key men without commensurate benefits. Progress reports like graphic charts are useful in telling not only position at any given time but direction and magnitude of change as well.

Interchange of personnel between research and manufacturing should be planned and adhered to as consistently as possible to make certain the problems of each department are understood by the other. It is not meant to use research specialists in operating jobs for which they are not temperamentally suited, but rather that

there should be at all times in each department a group well grounded in the workings of the other.

War Plants Will Not Revert To Cotton or Corn Fields

By M. H. Kotzebue

Chief engineer and manager, Gasoline Plant Construction Corp.

THE future of petrochemistry, including synthetic rubber from petroleum ingredients, will depend upon operating economics and the production of a superior finished product.

New materials and equipment have been brought into mass production and are now available to essential plants necessary to our war effort, the full effect of which will become more noticeable as new plants reach maximum production and operating personnel become familiar with their possibilities.

"Soft spots" caused by war shortages of metals, especially of alloys and nonferrous metals, will have to be corrected, giving employment and tiding over market changes as well as plant changes.

Contrary to many predictions by newspapers and those not familiar with the equipment, markets, and processes, few, if any of these war plants will revert to "cotton or cornfields."

Industry Has Two Parallel Incentives for Postwar

By J. W. Newton

Vice president and general manager, Magnolia Petroleum Co.

CATALYTIC-CRACKING facilities have increased five-fold during the war to approximately one-fifth of the national crude-charging capacity, and this equipment will be almost completely converted to peacetime needs during the immediate postwar period. The quick transition, accomplished primarily by the elimination of retreating and excessively high-temperature operations, should place the motor-fuel production of a number of companies well in advance of engine design and will undoubtedly accelerate the rapid development of lighter, more powerful engines to take full advantage of the improved fuels possible. In turn, this will probably result in a further large and general increase in catalytic-cracking equipment.

The necessity of conserving crude supplies while maintaining high quality products will be a parallel incentive for this expansion and will dictate other changes in processing techniques. It is likely that further refinements in charging heavy residua to both catalytic and thermal cracking units will be necessary. Losses to dry gas must be minimized through better disposition of the more useful constituents. Increased liquid recovery of desirable components should be effected by utilization of expanded fractionating capacity to recover select cuts and reject low quality fractions for further improvement.

Conservation, Economy, Quality, Will Guide Processing Choice

By J. B. Rather

Manager, research and development, Socony-Vacuum Oil Co., Inc.

TODAY catalytic and thermal cracking are the two principal means for converting petroleum fractions into motor fuels. Catalytic cracking excels thermal cracking because it produces gasolines of much higher antiknock quality, better stability and lower sulfur content. Likewise, catalytic cracking results in a more favorable balance between by-product yields and dry gas, butane-butylenes, and light fuel oils. For these reasons, in the future we may expect a gradual replacement of thermal cracking equipment by catalytic equipment. Thermal equipment of the coking and viscosity-breaking type will probably continue to hold positions of prominence partly as means for upgrading residual stocks and partly for preparing feed stocks to catalytic units. Likewise thermal processes of the polyforming, gas reversion and reforming type should hold positions of prominence for a considerable length of time due to their ability to upgrade low-grade naphthas and C_3 and C_4 fractions into high-quality motor fuels in an economical manner. However, catalytic reforming will undoubtedly give strong competition to the latter processes and may eventually displace them.

Future refinery operations will undoubtedly center about catalytic cracking for the basic conversion of heavy oils into light products. Catalytic cracking will be supplemented to a large extent by synthetic processes such as alkylation, polymerization, and isomerization for the production of maximum yields of useful products of high quality. Conservation, economy and quality will guide processing choice and development.

Higher Octane Standards Certain to Be Demanded

By F. A. Dearing

Superintendent, Kanotex Refining Co.

AFTER the war, all refiners who are not equipped with plants for making high-octane aviation-grade gasoline will undoubtedly be faced with the necessity of installing units to produce material of this nature, for blending up their motor gasoline to meeting rising octane standards.

There is considerable doubt as to just what these standards will be and how fast they will rise, but none that they will be higher than prewar.

For the smaller refiners, this added equipment will virtually be required to consist of adjuncts to existing thermal or combination units, for reasons of first cost and operating economy. To date not much research work has been done along this line, but it is to be hoped that the removal of wartime restrictions will stimulate it so that such auxiliary units will be available when needed. Present designs for high-cost highly specialized complete units will not be applicable.

Pooling of Resources Is Way to Better Efficiency

By J. F. Pritchard

President, J. F. Pritchard & Co.

FROM the vantage point of our organization in dealing with diverse groups and fields in the industry, we are able to discern certain trends and tendencies that point to future developments.

Foremost is the recovery of lighter hydrocarbons in the cycling process direct from the ground and their adaptation to various refinery processes. This represents a trend of comparatively recent origin that has rapidly grown to impressive proportions and developments.

Along with this development has

On Stream — the FIRST Fluid Catalytic Cracking Plant basically designed by Universal Oil Products Company — Engineered and Constructed by Frick-Reid Supply Corporation, now operating as JONES & LAUGHLIN SUPPLY COMPANY.

been the growth of the completely integrated refinery involving the different processes and making use of the constant developments of research. This tendency has resulted in the growth of capital refinery investment and a corresponding increase in the complexity of individual plants. Hand in hand with this development has been the various methods and operations of pooling of resources of the smaller operators to make efficient and economical use of such processes which would otherwise not be feasible.

Such trends and tendencies, although definite, are of course still in their initial stages and great strides along these lines can be expected in the future, all of which are in the direction of improving our over-all economy.

Research to Put Into Use Its War-Hardened Muscles

By D. E. Carr

Manager of research, Union Oil Co. of California

IT is a somewhat terrifying but undeniable fact that research is stimulated rather than depressed by war. This is true not only in the limited sense of meeting commercial military demands (exemplified by the almost incredible accomplishments in aviation gasoline), but it is also true of progress along more fundamental lines. In hydrocarbon chemistry during the last few years fresh fields of organic compounds have been opened up which will require decades to explore and to exploit commercially.

It is possible that the urgency for doing something that can't possibly be done (but somehow gets done) is responsible for the recent amazing strides into the unknown. A certain fine recklessness of imagination is generated, and in the break-through of the supposedly impregnable scientific Siegfried lines whole new continents of chemical knowledge are made accessible.

This is particularly true in the chemistry of isoparaffins, diolefins, and naphthenes. We are on the verge of seeing new postwar chemical subindustries deriving from unexpected reactions stumbled upon in the study of utilizing such compounds for wartime purposes. New, precise and powerful methods of isolation and purification are enabling the petroleum chemist to avoid the perennial criticism of the chemical industry proper, i.e., that he starts his reactions with messes of compounds and ends up with worse messes.

From the research standpoint the most unmistakable sign of a healthy industry is the fact that the latest textbooks are always out of date. On this criterion petroleum chemical research is, indeed, in a robust condition. With a new set of war-hardened muscles its continued progress should be both brilliant and substantial.

Octane Rating of House-Brand Fuels Due for Rise

By W. R. Newman

Vice president, The Frontier Refining Co.

FROM predictions that have been made by some industries closely associated with the oil industry it seems reasonable to assume at this time that major trends in refining, immediately after the war, will be toward the production of house-brand motor fuels having a power rating of around 80 octane, and premium fuels of around 85 octane.

It also seems safe to assume that the antiknock qualities of these respective fuels will increase gradually over a period of 5 years to 85 and 95. By reason of this quality fuel being somewhat out of the range possible to attain by thermal cracking, it is the opinion of some refining technologists that the average refiner will be required to augment thermal cracking with catalytic cracking if he is to compete for motor-fuel markets. Therefore, it appears that a great deal of engineering and development work will be required in catalytic cracking to reduce initial installation costs per unit of capacity, as well as operating costs per unit of capacity, in order that the average refiner can afford such implementation of his present facilities and still be competitive in the marketing field.

Industry Can Expect Rapid Development in Natural-Gas Conversion

By E. J. Hudson

Consulting Engineer

MILLIONS of dollars and hundreds of thousands of manhours are being spent yearly by the larger oil, chemical and engineering organizations in natural gas research. With the coming of peace and under favorable economic and tax conditions we can expect rapid commercial development based upon the laboratory and pilot plant process techniques already proven for conversion of natural gas components to a kaleidoscopic variety of chemicals through controlled oxidation, cracking, dehydrogenation, chlorination and combinations of these reactions.

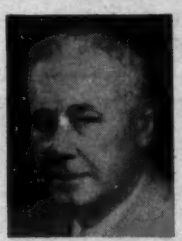
By the use of the Fisher-Tropsch process, as modified through the results of past and presently progressing pilot plant work, and in combination with catalytic or thermal cracking, the commercial production of a wide range of liquid petroleum products from dry natural gas will not long be delayed, if the price differential between crude oil and gas is sufficiently large.

Rapid Depletion of Natural Resources Is Biggest Problem

By F. E. Holsten

Executive vice president, Chalmette Petroleum Corp.

THE present emergency has contributed greatly to the technical knowledge and operating efficiency of the refining industry. This has been accomplished by the cooperation of all segments of the industry, including both large and small units, and is largely due to the pooling of technical information to the advantage of all. One of the greatest problems the industry must face in the postwar period is the rapid depletion of our natural resources, particularly petroleum. The prevention of wasteful and uneconomical refining will be of considerable aid in stopping this wastage. A continuation of the present cooperation can help very materially in accomplishing such a program.



Closer cooperation by trade associations will also help in making such a program possible. They are a concentration point for such material and should be used to distribute such necessary information to their members, to associations in the same branches of the industry and, when necessary, to the public.

Another important postwar necessity is the development of a catalytic cracker within the reach of the bank roll of the smaller refiners. It is rumored such a unit is in the process of development, but so far it has not been offered for sale.

Above all, let's hope that the postwar period will see industry using its own good judgment in operating its busi-

ness with as little government hindrance as possible.

Catalytic Processes Must Be Adopted by Smaller Plants

By H. W. Camp

Manager refinery division, Cities Service Oil Co.

THERE is little doubt that the future of petroleum refining will be greatly influenced by the volume and quality of crude oil that is available to the industry. The obvious necessity of most efficiently utilizing these irreplaceable resources dictates expansion of the relatively new catalytic processes. Thus, through use of new and improved methods, greater quantities of lighter fuels of high quality would be possible, with the resultant decrease in heavier products for which more plentiful fuels may be substituted.

Because of their close integration with the war program, most installations of these catalytic processes have been in large plants. One of the most pressing and immediate postwar needs will be their further development so that they may be economically utilized by smaller refining units.

Wartime programs for the manufacture of chemicals from petroleum for conversion into synthetic rubber, aviation fuels, explosives and other products have indicated the importance of petroleum as a raw material for organic chemical synthesis. Production of rather large volumes of petroleum gases by certain catalytic processes has stimulated both proven and new processes for their conversion into a wide variety of products.

Greatest Immediate Need Is Adequate Crude Supply

By Fred C. Koch

Koch Engineering Co.

THE greatest need of the refining industry at this time is an adequate crude supply. Perhaps this shortage of crude will lead to decreased use of burner and bunker oils with heavy tars along with fixed gases from cracking operations being employed as raw material for the Fischer-Tropsch process wherein they are reconstituted into desirable hydrocarbons. This of course presumes on the use of coal as fuel.

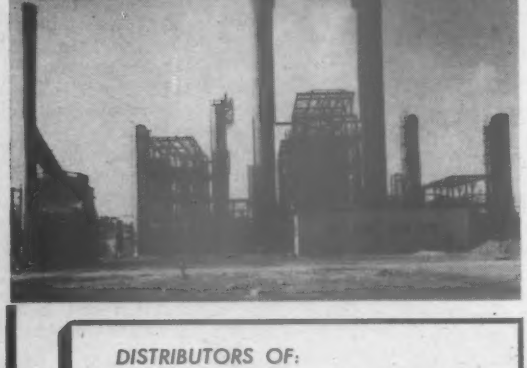
The field of petroleum chemistry is just beginning to unfold and its possible ramifications stagger the imagination. The most immediate problem is what is going to be done with the government-owned ammonia plants. They represent an enormous investment and contain equipment which can be employed in the manufacture of methanol, formaldehyde and other chemicals in addition to ammonia and fertilizers.

Aviation Gasoline "Tailor Made"

The chemist is learning how to go up and down the scale of hydrocarbons. Aviation gasoline is "tailor made," employing several pure hydrocarbons. Tailor-made or synthetic lubricating oil should give exactly the desired characteristics.

A development of tremendous significance not too far away is the conversion of natural gas into liquid hydrocarbons by the Fischer-Tropsch synthesis.

Perhaps the shortage of crude rather than antiknock characteristics will dictate motor-fuel specifications. Catalytic and thermal-cracking processes are both valuable tools of the petroleum engineer. It seems that thermal cracking will continue to be employed although perhaps not as extensively as in the past.



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Allies' Aviation-Fuel Needs Supplied By More Than 170 Units

IN the accompanying table is a complete list of the units operating or building for supplying the Allies' requirements of 100 - octane - number aviation fuel. The greater number of these were projected just before and after Pearl Harbor, to handle the tremendous air-force program which the new cataclysm demanded. These units will be operated by the various refining companies, and some 50 companies are involved in the operation. The largest number of companies interested in any one plant are the eight refiners cooperating in the Associated Refineries, Inc., plant near Duncan, Okla.

This program will cost $900,000,000 to build. Prior to Pearl Harbor it is estimated that we were producing 40,000 bbl. or less of 100-octane-number aviation fuel. A few privately owned plants were operating in a competitive way to make the components and the finished fuels. While no announcement is made regarding the final total capacity of the program, it is estimated that these plants along with auxiliary production in other refineries, will supply considerably more than ½ million barrels per day. This is nearly double the production of all gasoline in the first World War.

These units include 60 catalytic crackers, fluid catalyst, T.C.C. and Houdry. In these units is prepared a catalytically cracked blending component of octane number of 80 or higher; it is high in aromatics, benzene, toluene, xylenes, and others of the benzene series, is high in isoparaffins and contains considerable amounts of olefins. For use in aviation fuel this distillate is "treated" a second time catalytically under conditions not disclosed for military reasons, to produce a more highly aromatic, more saturated product with the required properties for making superfuels. This "cat-cracked distillate" is the so-called base stock which makes up a large part of the finished aviation fuel, supplying much of the aromatic and isoparaffinic material which give the fuel its special properties.

The 60 alkylation units combine isobutane and small amounts of other isoparaffins with butene or isobutene to form commercial isooctane or "alkylate," with octane ratings of 90-95. This alkylate adds especially the high-octane-number qualities indispensable in the finished fuel, and may make up 30 per cent or more of the finished fuel, an all-important component. These alkylation processes, two main methods, are both catalytic, are new developments and are of extreme importance in the program.

Isomerization units, 31 of them, produce the additional amounts of isoparaffins, mainly isobutane, which are required for the alkylation reaction. Much isobutane is found as such in the light products from catalytic units. Considerable amounts are found in natural gasoline and in the vapors from distillation processes in refineries. Generally, these naturally occurring amounts are not sufficient to meet present demands, hence the need for building these isomerization units to augment the supply. By this means adequate supplies of charge stocks for alkylation are insured.

In addition to these major components of aviation fuel, several others are made as auxiliary products from numerous refinery installations, either in new or old units. Isopentane has an octane number of 92-94, a high volatility and is obtained by concentration of the naturally occurring material in natural gasoline and light fractions of crude. Several refiners who have raw materials available are concentrating this fraction and supplying it to other refiners who are blending the finished product.

Cumene, toluene, and benzene are aromatics which are being synthesized or concentrated from suitable stocks for use in these fuels. These products add the desired qualities to the fuels, qualities needed to give the superperformance required of our aircraft. To augment the supply of alkylate many refiners are operating catalytic polymerizers selectively to produce isooctene by polymerization of butenes from cracked gases to form the so-called codimer. This codimer is hydrogenated in two or more units to form hydrocodimer, approximately equivalent in composition and octane rating to alkylate. This product is especially important now, to increase the total output of high-octane material needed in the program. As the alkylate output is increased it may be possible to reduce the codimer output, the answer being determined by the then existing demands for isooctane.

(Table begins on next page)

Charging 20,000 bbl. per day to two T.C.C. units, Magnolia makes aviation base stock, plus butenes, isobutane, and toluene

Complete List of 100-Octane Units Operating or Building

Company and plant location—	Completed units— Type	Completion date	Units building— Type	Scheduled completion
J. S. Abercrombie-Harrison Oil Co., Sweeney, Tex.	Crude topping unit	November 1943	Fluid catalytic cracking	Spring 1944
	Thermal reforming	November 1943	Isomerization	Summer 1944
	Alkylation	March 1944		
Atlantic Refining Co., Atreco, Tex.	Alkylation	February 1944	Fluid catalytic cracking	Spring 1944
			Alkylation	Spring 1944
Atlantic Refining Co., Philadelphia, Pa.	Alkylation	March 1943	Fluid catalytic cracking	Spring 1944
Ashland Refining Co., Catlettsburg, Ky.			Thermofor catalytic cracking	Spring 1944
			Alkylation	Spring 1944
Associated Refineries, Inc., Duncan, Okla.			Fluid catalytic cracking	Spring 1944
			Alkylation	Spring 1944
			Isomerization	Spring 1944
Champlin Refining Co., Enid, Okla.	Alkylation	February 1944		
	Isomerization	February 1944		
Cities Service Oil Co., East Chicago, Ill.	Alkylation	April 1943		
	Isomerization	April 1943		
Cities Service Ref. Corp., Lake Charles, La.	Topping unit No. 1	November 1943	Fluid catalytic cracking No. 1	Spring 1944
			Fluid catalytic cracking No. 3	Spring 1944
	Fluid catalytic cracking No. 1	February 1944	Topping unit No. 2	Spring 1944
	Alkylation No. 1	March 1944	Alkylation No. 2	Spring 1944
Continental Oil Co., Ponca City, Okla.			Isomerization	Spring 1944
			Thermofor catalytic cracking	Spring 1944
			Alkylation	Spring 1944
			Isomerization	Spring 1944
Continental Oil Co., Lake Charles, La.	Alkylation	January 1943		
Continental Oil Co., Wichita Falls, Tex.	Alkylation	December 1942		
Cooperative Ref. Assn., Coffeyville, Kans.			Fluid catalytic cracking	Spring 1944
			Alkylation	Spring 1944
			Isomerization	Summer 1944
Crown Central Pet. Corp., Houston, Tex.			Thermofor catalytic cracking	Spring 1944
			Alkylation	Spring 1944
			Isomerization	Spring 1944
Eastern States Pet. Co., Inc., Houston, Tex.	Alkylation	February 1944		
	Isomerization	February 1944		
	Fluid catalytic cracking	February 1944		
Frontier Refining Co., Cheyenne, Wyo.			Alkylation	Spring 1944
			Isomerization	Spring 1944
			Fluid catalytic cracking	Spring 1944
General Pet. Co., Torrance, Calif.	Alkylation	December 1943		
	Thermofor catalytic cracking	February 1944	Thermofor catalytic cracking	Summer 1944
Great Southern Corp., Corpus Christi, Tex.	Alkylation	February 1944	Dehydrogenation	Spring 1944
Gulf Oil Corp., Port Arthur, Tex.	Houdry catalytic cracking	April 1943		
	Alkylation	April 1943		
	Thermofor catalytic cracking	September 1943		
Humble Oil & Ref. Co., Baytown, Tex.	Fluid catalytic cracking	January 1943	Hydrogenation	Summer 1944
	Alkylation	January 1943		
	Fluid catalytic cracking	January 1944		
Magnolia Pet. Co., Beaumont, Tex.	Alkylation	July 1943		
	Houdry catalytic cracking	July 1943		
	Thermofor catalytic cracking	August 1943		
Mohawk Pet. Corp., Bakersfield, Calif.	Alkylation	January 1944		
	Isomerization	January 1944		
Pan American Ref. Co., Texas City, Tex.	Fluid catalytic cracking	March 1944		
	Butylene	March 1944	Isomerization	Late 1944
Pennzoil Co., Oil City, Pa.			Alkylation	Spring 1944
			Fluid catalytic cracking	Spring 1944
Phillips Pet. Co., Borger, Tex.	Alkylation	January 1943	Catalytic cracking	Spring 1944
			Alkylation	Spring 1944
			Isomerization	Spring 1944
Phillips Pet. Co., Kansas City, Kans.	Alkylation	June 1943		
	Alkylation	November 1943		
	Isomerization	November 1943		
Premier Ref. Co., Cotton Valley, La.	Alkylation	February 1944		
	Dehydrogenation	March 1944		
Pure Oil Co., Smiths Bluff, Tex.	Alkylation	November 1943		
	Thermofor catalytic cracking	February 1944		
Richfield Oil Corp., Watson, Calif.	Alkylation	February 1943		
	Isomerization	February 1943		
Richfield Oil Corp.			Alkylation	Summer 1944
			Thermofor catalytic cracking	Summer 1944
Republic Oil Ref. Co., Texas City, Tex.	Alkylation	February 1944	Fluid catalytic cracking	Spring 1944
Root Pet. Co., El Dorado, Ark.	Alkylation	February 1944		
	Isomerization	February 1944		
	Fluid catalytic cracking	February 1944		
Shell Oil Co., Inc., Wood River, Ill.	Alkylation	July 1943	Hydrogenation	Summer 1944
	Fluid catalytic cracking No. 1	January 1944		
	Fluid catalytic cracking No. 2	February 1944		
Shell Oil Co., Inc., Wilmington, Calif.	Alkylation	August 1943		
	Isomerization	August 1943		
	Fluid catalytic cracking	October 1943		
	Hydrogenation	March 1944		
Shell Oil Co., Inc., Houston, Tex.	Alkylation	July 1943		
	Isomerization	July 1943		
Sinclair Ref. Co., Corpus Christi, Tex.			Houdry catalytic cracking	Spring 1944
			Alkylation	Spring 1944
Sinclair Ref. Co., Sinclair, Wyo.	Alkylation	December 1943	Fluid catalytic cracking	Spring 1944
	Isomerization	December 1943		
Sinclair Ref. Co., Houston, Tex.	Alkylation	March 1943		
	Houdry catalytic cracking	April 1943		
	Thermofor catalytic cracking	March 1944	Depentanizing unit	Spring 1944

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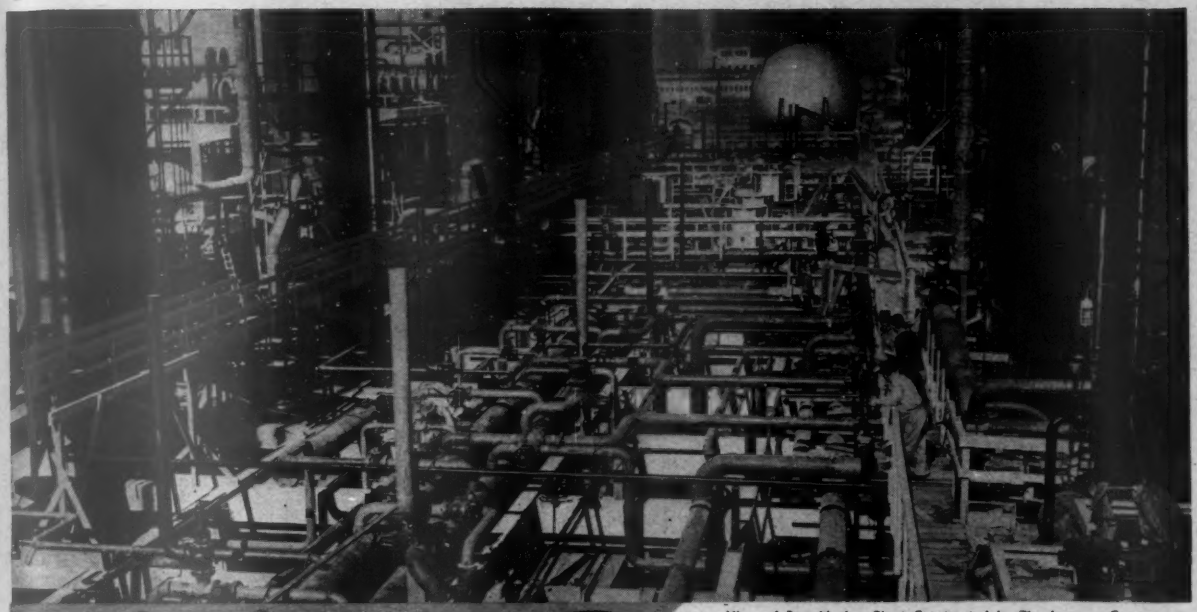


View of Port Neches Plant Constructed by The Lummus Company.

Shining Example

OF TEAMWORK

When the huge Port Neches butadiene plant went on stream, its gleaming tanks and towers marked a milestone of teamwork . . . of voluntary cooperation by leading refiners who pooled research facilities, patents and manpower in the common purpose of producing the ingredient their country needed.

Manufacturers and distributors, too, pooled their resources . . . turned their efforts toward teamwork rather than competition. Urgent items were drawn from many reliable sources, Watson-Stillman being proud to have shared in this gigantic program by furnishing a substantial portion of the fittings Port Neches needed in its many miles of pipelines.

Shining Example

OF COST-SAVING

The W-S double diamond is the mark of fittings that have been built to high standards which assure users of low maintenance cost. In the case of W-S Socket Welding Fittings, further cost-saving is made possible by reductions in material and welding costs.

W-S Fittings for both screwed and socket welding joints are available for Standard Pipe, Extra Heavy Pipe and Double Extra Heavy Pi

Perfection of metal structure is insured in all W-S Fittings by only materials that conform to rigid chemical and physical spe tions. This precaution plus extreme accuracy and uniformity in machining assures users trouble-free service with all W-S Fittings.

Write for Bulletin A-3 containing complete details, specifications and engineering data for all Watson-Stillman Fittings. The Watson-Stillman Co., Roselle, N. J.

WATSON-STILLMAN

Distributor Products Division

DESIGNERS AND MANUFACTURERS OF FORGED STEEL FITTINGS, VALVES, AND HYDRAULIC EQUIPMENT

3316

Complete List of 100-Octane Units Operating or Building (Continued)

Company and plant location—	Completed units		Units building	
	Type	Completion date	Type	Scheduled completion
Socony-Vacuum Oil Co., Inc., East St. Louis, Ill.			Thermofor catalytic cracking	Spring 1944
			Alkylation	Spring 1944
Socony-Vacuum Oil Co., Inc., East Chicago, Ind.	Houdry catalytic cracking	October 1942		
Socony-Vacuum Oil Co., Inc., Augusta, Kans.	Alkylation	June 1943		
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.			Alkylation	Spring 1944
			Thermofor catalytic cracking	Summer 1944
Socony-Vacuum Oil Co., Inc., Buffalo, N. Y.	Houdry cat. crack. (revamping)	October 1943		
Socony-Vacuum Oil Co., Inc., Brooklyn, N. Y.	Houdry cat. crack. (revamping)	January 1943		
Socony-Vacuum Oil Co., Inc., Trenton, Mich.	Houdry cat. crack. (revamping)	December 1942		
Southport Pet. Co., Texas City, Tex.	Houdry catalytic cracking	January 1944		
	Alkylation	March 1944		
Standard Oil Co. of California, El Segundo, Calif.	Houdry catalytic cracking	September 1942		
	Isomerization	September 1943		
Standard Oil Co. of California, Richmond, Calif.	Thermal cracking	July 1942	Alkylation	Late 1944
			Thermofor catalytic cracking	Late 1944
Standard Oil Co. (Indiana, Whiting, Ind.	Hydroforming	September 1943		
	Naphtha isomerization	December 1943		
	Alkylation	December 1943		
	Isomerization	December 1943		
	Fractionation	February 1944		
Standard Oil Co. (Indiana), Wood River, Ill.	Fluid catalytic cracking	February 1944	Alkylation	Spring 1944
			Isomerization	Spring 1944
Standard Oil Co. of Louisiana, Baton Rouge, La.	Alkylation	February 1943		
	Fluid catalytic cracking	September 1943		
	Blending agent unit	December 1943		
	Hydrogenation	January 1944		
Standard Oil Co. of New Jersey, Bayway, N. J.	Fluid catalytic cracking	December 1942		
Standard Oil Co. of New Jersey, Baltimore, Md.	Alkylation	December 1942		
	Fluid catalytic cracking	December 1943		
Standard Oil Co. (Ohio), Cleveland, Ohio			Houdry catalytic cracking	Spring 1944
Standard Oil Co. (Ohio), Toledo, Ohio	Alkylation	July 1943		
Sun Oil Co., Marcus Hook, Pa.	Alkylation	July 1943		
	Houdry catalytic cracking	August 1943	Thermofor catalytic cracking	Summer 1944
The Texas Co., Port Arthur, Tex.	Isomerization, alkylation	March 1943	Fluid catalytic cracking No. 2	Spring 1944
	Alkylation	October 1943		
	Fluid catalytic cracking No. 1	February 1944		
The Texas Co., Lockport, Ill.	Alkylation	April 1943		
	Isomerization	April 1943		
	Hydroforming	April 1943		
The Texas Co., Wilmington, Calif.			Alkylation	Summer 1944
			Fluid catalytic cracking	Summer 1944
Tide Water Associated Oil Co., Avon, Cal.	Alkylation	June 1943	Isomerization	Summer 1944
	Isomerization	June 1943		
	Alkylation	December 1943	Fluid catalytic cracking	Late 1944
	Isomerization	December 1943		
Tide Water Associated Oil Co., Bayonne, N. J.	Houdry cat. crack. (revamping)	December 1943	Thermofor catalytic cracking	Late 1944
Union Oil Co. of Calif., Wilmington, Cal.	Thermal reforming	April 1943		
	Thermal cracking	February 1944		
	Alkylation	March 1944	Alkylation	Summer 1944
	Isomerization	March 1944	Thermofor catalytic cracking	Summer 1944
Utah Oil Ref. Co., Salt Lake City, Utah	Fluid catalytic cracking	March 1943		
	Alkylation	March 1943		
	Isomerization	March 1943		
	Naphtha isomerization	March 1943		
Wilshire Oil Co., Norwalk, Calif.	Alkylation	December 1943		
	Isomerization	December 1943		
	Fluid catalytic cracking	February 1944		
FOREIGN UNITS				
Anglo-Iranian Oil Co., Abandan, Persia	Alkylation	October 1943	Alkylation	Summer 1944
	Superfractionation	October 1943	Superfractionation	Summer 1944
			Alkylation	Late 1944
			Isomerization	Late 1944
Asiatic Pet. Corp., Curacao, N.W.I.	Cumene	February 1944		
	Alkylation	March 1944		
	Isomerization	March 1944		
Bahrein Pet. Co., Bahrein Island			Fluid catalytic cracking	Late 1944
			Alkylation	Late 1944
			Isomerization	Late 1944
Imperial Oil Co., Ltd., Calgary, Alta.	Alkylation	April 1943		
Lago Oil & Transport Co., Ltd., Aruba, N.W.I.	Alkylation	September 1943		
	Fluid catalytic cracking	December 1943		
Shell Oil Co., Montreal, Canada			Alkylation	Spring 1944
U.S.S.R., Russia			Houdry catalytic cracking	Late 1944
			Alkylation	Late 1944

Brown Electronik Potentiometers on Main Control panel board of Houdry Catalytic Cracking Unit. Sun Oil Company 100-Octane Aviation Gasoline Refinery, Marcus Hook, Pa.

Balance Must Be Continuous

In the Brown *Electronik* Potentiometer Controller a *"Continuous Balance"* Unit takes the place of the galvanometer used in the conventional mechanical-type potentiometer employing a periodic or cyclic mechanism.

The Brown *Electronik "Continuous Balance"* measuring system makes it possible to take full advantage of thermocouple responsiveness. Positive control action is assured by the well-known, dependable Brown *Air-o-Line* Control Unit.

Outstanding features such as: Control Unit—Throttling Range Dial—Automatic Reset Dial—Booster Pilot Valve—Control Index Knob—Direct and Reverse Action—Compression Type Fittings—Control By-Pass Panel—Balancing Motor—Slide Wire—Pen Arm Release—Chassis—are fully described in Bulletin 15-4. Write for it.

Helping to Boost Output of 100-Octane Gasoline

Now in full operation, Sun Oil Co.'s newest aviation gasoline plant is one of the largest of its type in existence. In this modern refinery all petroleum components of aviation gasoline are produced and blended into the finest fighting fuel.

In selecting the control instruments for this new refinery, nothing was spared to make this plant a model of modern efficiency. Contributing to this operating efficiency are Brown *Electronik* Potentiometer *Air-o-Line* Controllers which hold temperatures within the exact limits.

The Brown *Air-o-Line Electronik* Potentiometer Controller, operating on the *"Continuous Balance"* Principle, brings to the oil industry the ideal synchronization of measurement and control for temperature processes. It is the only potentiometer-type controller in which the air control flapper mechanism is continuously positioned in response to temperature changes. Hundreds of installations have proved its sensitivity . . . ruggedness . . . simplicity . . . precision and unequalled ease of adaptation to process requirements. The Brown Circular Chart *Air-o-Line Electronik* Potentiometer Controller is the result of years of research, design and field testing.

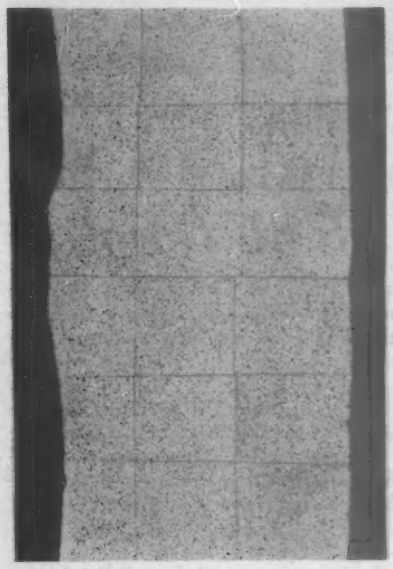
Write for Bulletin 15-4. The Brown Instrument Company, a division of Minneapolis-Honeywell Regulator Company, 4488 Wayne Avenue, Philadelphia 44, Pennsylvania. Offices in all principal cities. 119 Peter Street, Toronto, Canada — Wadsworth Road, Perivale, Middlesex, England — Nybrokajen 7, Stockholm, Sweden.

BROWN *Electronik*
POTENTIOMETERS

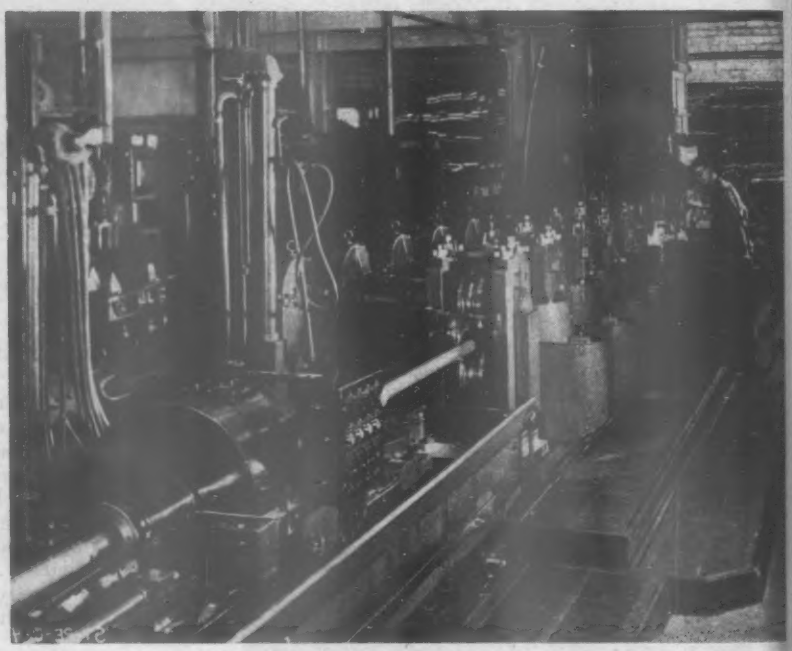
Welding of Refinery Tubes Involves Complicated and Exact Technique

*by J. Fred Keeler**

Flat-rolled steel being fed into the forming rolls—the entrance end of the tube welding machine



Photomicrograph of tube wall at weld. Straight lines are edges of individual photographs used to produce composite picture



Over-all view of welding machine. The welding unit at left, immediately in front of operator; straightening and sizing rolls; the cut-off unit in right foreground

THE petroleum industry is today challenged to maintain production at the highest possible level of efficiency and safety. Toward that end, hazards, installation time, and replacements are watched even more vigilantly than usual. These phases of operation are of the utmost importance now when "offstream" time means lost production that can never be made up.

Under these conditions, new products in the industry are under constant observation by those whose responsibility it is to see that all functions within the refinery are carried on without interruption. Engineers and maintenance men who have been observing the performance of Electrunite tubing have seen this comparative newcomer prove itself in the refinery field just as it has in other fields of use during the past 12 years.

Electrunite tubes are in service today in virtually all types of refinery installations—as well as in power boilers, heating boilers, evaporators, and refrigeration equipment. The process by which this product is made is responsible for the inherent qualities which the manufacturer claims as advantages.

Steel Received in Large Coils

Hot-rolled steel which has been pickled to remove all scale is the raw material used for heavy-wall tubing, while cold-rolled, scale-free steel is generally used for lighter-wall tubing. The steel is received in large coils with the edges trimmed or sheared, so as to have a uniformly accurate width throughout its length. Both sides of the steel are thoroughly inspected at the rolling mill and again upon arrival at the tube plant for surface defects, temper, gage, and width. The operation from this point forward is continuous—with the forming, welding and sizing units contained in one massive machine.

The flat-rolled steel is fed cold into the forming section, which consists of a series of roll passes that form the flat stock into a butted cylinder. This cold-forming process tends to accentuate rather than conceal any surface defects that may have been present in the flat-rolled steel.

The tube is then propelled into the welding section of the machine. This is composed of a pair of disks or circular electrodes, insulated from each

*Manager of product engineering, Republic Steel Corp., Steel and Tubes Division.

WORTH LOOKING FOR

In these days when every ounce of metal is critical, and when every barrel of refinery capacity is vital, it will pay you to look for the Sivyer mark on Safety Return Bends, Alloy Tube Supports, and other Special Refinery Castings. For that Sivyer mark is your assurance of sound design, rugged construction, and integrity of metal. These are the qualities which mean long life, freedom from trouble, and fewer replacements. They are the qualities which make the Sivyer mark now, more than ever, "Worth Looking For."

SIVYER STEEL CASTING COMPANY

MILWAUKEE CHICAGO

other and mounted on a single horizontal shaft. Each of the electrodes makes contact with the tube on its side of the butted seam. Directly under the electrodes is a pair of hardened steel rolls, mounted separately on vertical shafts. Each roll has a groove of the same contour as the circumference of the tube, and is mounted so as to surround the tube for a distance of about 90°.

Electric current of high amperage is fed to the electrodes and through them, across the tight-butted seam of the tube. The welding heat is generated by the resistance of the joint to the flow of the current. Mechanical pressure is applied by the supporting rolls at the instant of welding, and the weld is immediately completed. There is no fusion of metal except possibly at the extreme contacting edges. No extraneous metal is added during the welding operation, the weld resulting solely from the union of the butted edges. The composition of the weld, therefore, is identical with that of the base metal.

A microscopic examination of a section of tubing taken directly from the welding machine without any subsequent heat treatment discloses that the structural change, that is, the change in microstructure resulting from the welding heat, extends even less than ⅛ in. on either side of the joint. This area is seldom over 1/10 in. wide, and is usually about ¼ in. wide. There is a slight increase in the size of this area in the very heavy wall tubes, but it is much less than one might anticipate.

The structure itself is of interest. Whereas a cast structure is typical when metal is molten to form a weld (as in fusion welding) and this cast structure has a sharp grain formation, the grain structure in the vicinity of the weld on this tubing remains more or less rounded, with some carbon diffusion. In other words, the welding heat has put the steel into solid solution and the rapidity of the cooling operation has resulted in the equivalent of a quenched steel. This accounts for the strength and ductility of the welded area. The anneal or normalizing treatment above the critical temperature produces complete recrystallization of the weld area, and it is generally impossible to locate the weld under the microscope.

The process is completely mechanical, once the operator has obtained the proper setup. The welding factors of current, speed, pressure and contact remain constant. The tube is actually welded slightly oversize and is reduced to the finished dimension in the sizing section of the machine. This consists of a series of roll passes of the exact diameter desired. These roll passes also round up the tube.

Expansion and flattening tests are made at the start of each new length of steel, and are then taken periodically as the tube is being welded. Where there is any indication whatsoever of an imperfect weld, the tube is scrapped and all preceding and succeeding tube is likewise scrapped until the machine operator has adjusted his machine to produce a weld which is free from defects. It is unnecessary to adjust the welder for each coil since the steel is run by heats, and experience has proved that when a setup is obtained on the first coil it is rare, indeed, that any difficulty is encountered with succeeding coils. Nevertheless, tests are taken continually as insurance against a defective section of tube.

A flash or upset is extruded on both inside and outside of the tube as a result of the pressure applied in making the weld. The amount of extruded metal in tubing welded by the Electrunite process is much less than would normally be expected. The outside flash is removed with a cutting tool as the tube leaves the welder, resulting in a perfectly smooth exterior surface. Republic engineers have also developed a method for removing the inside flash with a cutting tool immediately after the welding operation. For tube sizes larger than 1 in., the cutting tools are usually adjusted for a maximum height of 0.010 in. The actual height of the flash varies between 0.000 in.

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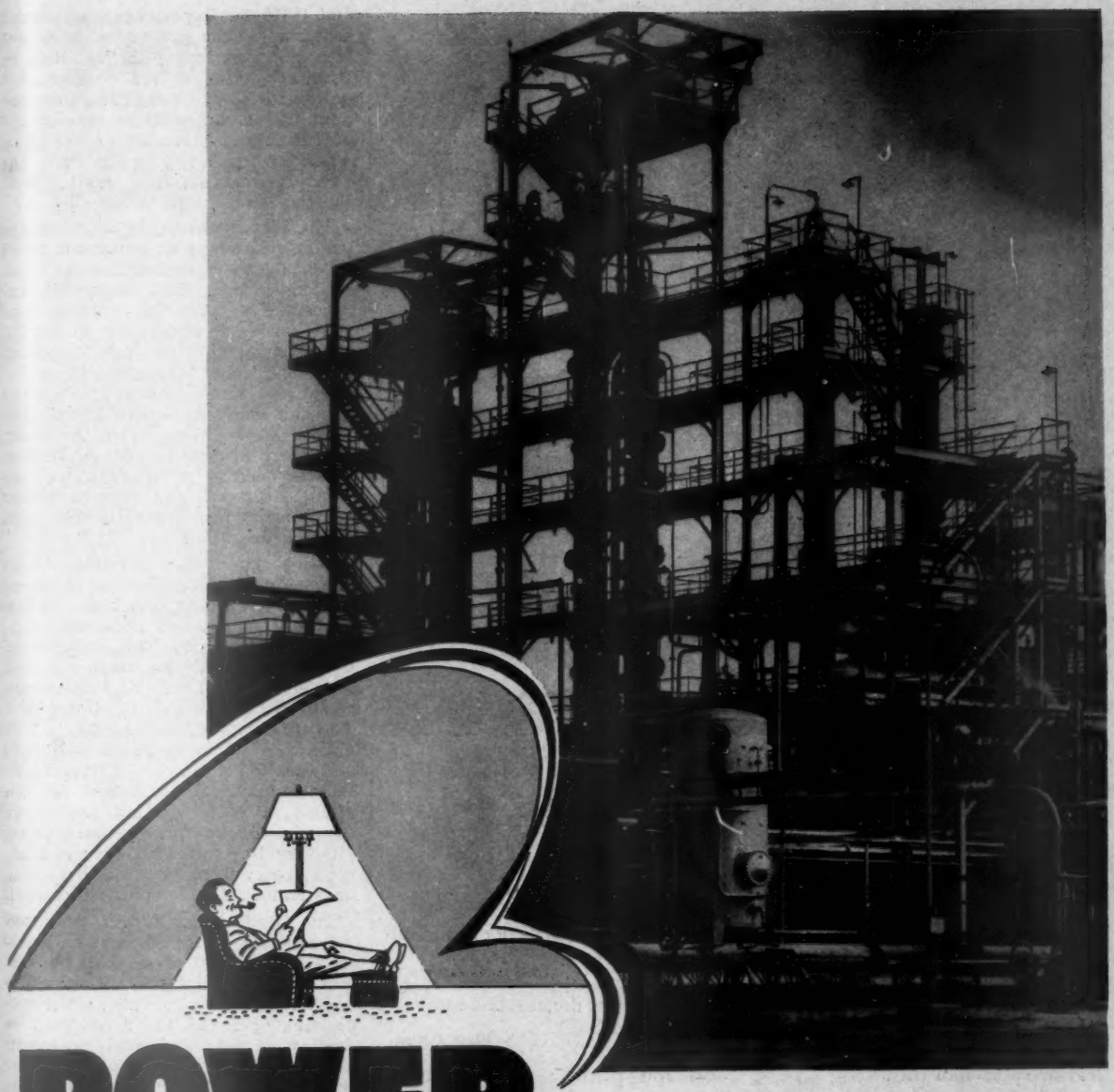

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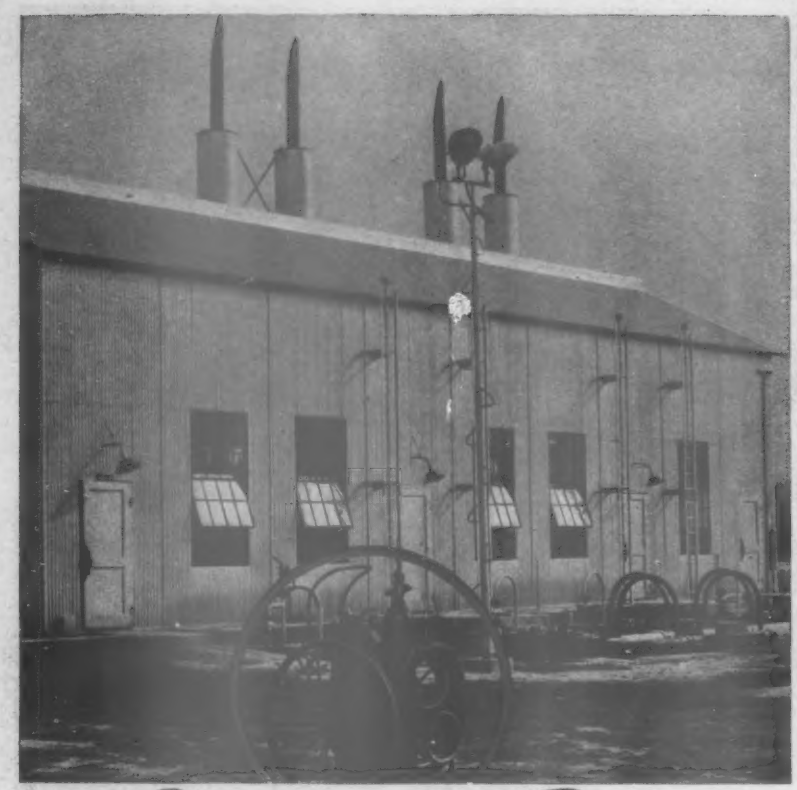

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and 0.010 in. Experience has proved that this slight protrusion does not interfere with rolling-in the tubes, or with any type of flue cleaner used on the inside of tubing. The inherent ductility of the weld is readily apparent in the character of the chips formed when removing the flash. Instead of breaking into small pieces, the flash comes off as one chip.

The tube is cut to the approximate length desired on an automatic press or on a lathe synchronized with the welding speed. This makes it unnecessary to stop the welding machine, either to obtain test pieces for inspection or to cut each length of tube. The welder operates without interruption once a coil of steel is fed into the machine, except at the discretion of the inspector in the event that there are mechanical or surface defects, such as scratches or the size being incorrect. The tube is under continuous inspection during the welding operation.

While "mechanical" grade tubing is generally used directly as it comes from the welding machine, boiler, heat exchanger, and condenser tubing is normalized. This consists of heating it above the upper critical temperature of 1,650° F., followed by cooling in a "controlled" atmosphere. The treatment gives the steel a fine grain size which means it is ductile and easy to roll in, yet tough and uniform in physical properties. All the effects of cold working caused by forming the butted tube and sizing after welding are removed, and complete recrystallization of both the base metal and the weld is produced.

The first boiler tubes produced were normalized in a conventional-type furnace and then pickled to remove all scale. However, to retain the original finish on the tube, which the pickling operation has a tendency to destroy, it was necessary to install a controlled atmosphere furnace. Subsequently, a second such furnace was put into operation. The first furnace was electric; the second furnace, gas-fired. In the latter, the fuel does not come in contact with the work but is passed through tubular muffles. In both furnaces, the atmosphere or gas which surrounds the work is generated externally and fed into the furnace to prevent oxidation and scaling of the tubing. The furnace operation is continuous, the tubes being fed into one end and passed on through a cooling chamber where they are dropped to a point below the scaling temperature before being discharged. The tubes are then carried directly into a blueing oven, where they are coated with an extremely thin, tightly adherent, blue oxide which is uniformly distributed over the surface. This coating is so thin it does not peel off.

All tubes are straightened after normalizing, and their ends trimmed to proper length in a lathe.

Scale Models Speed Fluid Catalyst Cracking Units

*by Joseph F. Skelly**

IN smoothly working ranks which energize our armies of the second front stand the nation's fluid catalyst-cracking plants. These towering structures run night and day with flowing catalyst to make the finest fuel known to modern science. Yet despite their mighty stature, they grew within 2 years from tiny scale models whose hand-made forms were hardly 30 in. high. Their builders now find time to report upon this work and to disclose some novel methods which may be of future benefit to the petroleum industry.

Recognized as pioneers in the development of fluid catalyst processes, The M. W. Kellogg Co. was asked to erect more than one-half of the United Nations' cracking capacity ordered after Pearl Harbor. This giant responsibility was to be fulfilled by the construction of many large catalytic-cracking plants in all of our country's main refining centers as well as in several overseas locations.

*Chemical engineering department, The M. W. Kellogg Co.

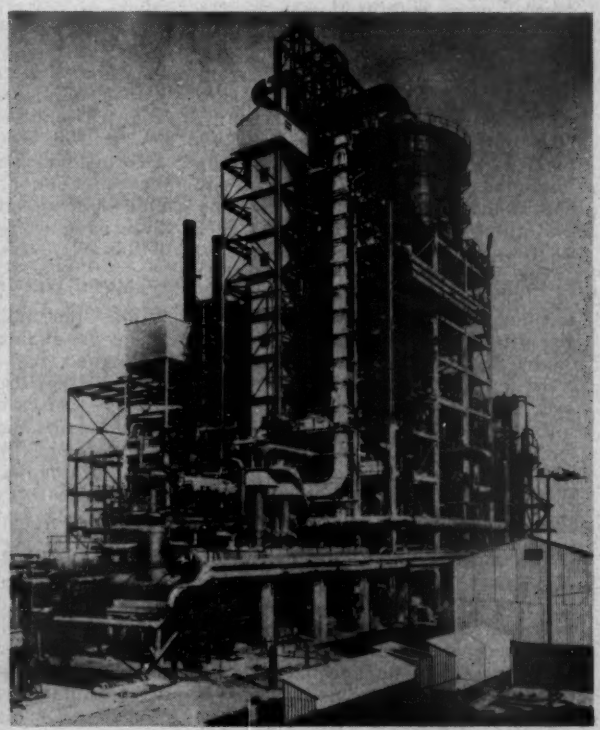
At that time the best available fluid catalyst process was still a pilot-plant project. In normal times several years are needed to bring a process from this stage to the point where it is ready to deliver a major portion of a great industry's output. New plants are usually built one by one, each unit containing improvements derived from the operating characteristics of its predecessors. Such was the history of thermal cracking. The exigencies of war demanded a much more rapid development of fluid catalysts, 10 or 15 years of normal progress being compressed into 2. This assignment necessitated some departure from the well-established policies of the company.

The company's peacetime business is always conducted on a "made-to-order" basis, each unit being specially designed and built to suit the requirements of the individual customer. But in December 1941 mass production of the new process required a considerable measure of uniformity in plant design. At the same time, every opportunity was seized to adapt each unit, so far as circumstances would permit, to the special needs of each customer.

Manpower Shortage First Problem

The first great problem to be solved was that of manpower, with acute shortages existing in the drafting and designing departments. The company anticipated the need for several hundred experienced piping draftsmen, but it knew that the national supply of these men was almost exhausted. Fortunately there were locally available many architectural draftsmen, who knew something about engineering and who were generally familiar with drafting-room methods.

During the ensuing 8 months small groups of these men (ultimately totaling about 200) were hired and put to work in a training school operated in the company's main offices. In 4 to 8 weeks each group learned to prepare



Model of Kellogg's fluid-catalytic cracking unit with its builder, Edmund Serafin. The model is made mostly of plastics and wood, is approximately 4 ft. 2 in. tall and is scaled at ¼ in. to the foot. This model is basic to the construction of all Kellogg fluid-catalytic cracking units. Right: The Kellogg fluid-catalytic cracking unit installed at Shell Oil Co., Inc.'s Dominguez, Calif., refinery. Note the almost exact duplication of the model shown in the illustration at left

From this intricate maze of pipes, girders, columns, and other equipment, members of the purchasing and engineering departments are able to ascertain valuable data to guide them in their recommendations, and to check costs and other items

detailed isometric piping drawings from existing plan and elevation views of a debutanizer unit erected several years before. It was at this point that scale models first became useful in the fluid catalyst program.

To assist the new men in visualizing this unfamiliar equipment, an exact scale model of the debutanizer unit was constructed. Special pains were taken to reproduce all important piping details so that the students might check their isometrics against the real thing—portrayed by the model as it faced the class at every session.

The combined "instructor model" team proved very successful in transforming exarchitects to competent engineering draftsmen. The students soon discovered that many of their problems were quickly solved by direct reference to the model, often without having to wait until the instructor was available for individual questioning. Classroom disputes were quickly settled by examination of the silent but irrefutable details shown in the model.

The final test of the effectiveness of this teaching method came when the new men were put to work on new catalytic-cracker designs as they were received from the process department. The students made good and many of them have since advanced to permanent positions in the company.

Other phases of the over-all problem benefited by the use of scale models. At first it was difficult to grasp the full implications and subtleties of the new process as applied to the large units then being designed. Many of the engineering personnel were influenced by attitudes developed in the thermal-cracking period of the previous decades. Extraordinary precautions were clearly needed to prevent mistakes arising from the relative unfamiliarity of the new process.

To this end the company undertook the construction, at the earliest possible moment, of a scale model catalytic cracker complete in all major details.

Model Was Immediate Success

Like the debutanizer unit, this model was an immediate success. Containing all the essential features of the basic Kellogg design, it was constantly consulted when selecting modifications made necessary by each field location. Project engineers, structural draftsmen, process men and executives all turned frequently to it for help. As fast as new design details were set, they were incorporated into the model, thus demonstrating visually the status of the job and indicating some of the requirements which later additions would have to meet. Piping men studied it endlessly for help in laying out lines and choosing advantageous support points. Job engineers consulted it when trying to foresee operating and maintenance difficulties.

Construction men found in the model a graphic picture of the job awaiting them in the field and process men sought its silent advice when evaluating some of the new schemes and ideas that constantly originate in their department. Operating crews and customers used the model as a basis for their own field preparations, and equipment vendors found it of great value when visualizing the nature of problems on which their advice had been solicited.

If deliveries were tight, the purchasing agents came for help in selecting substitute materials and items on which better delivery could be obtained. Even after field work was well under way, the model still contributed to the progress of the job. At several locations construction shutdowns were imminent due to delayed shipment of some essential items. In these cases the model often indicated those portions of the job which could be continued pending the arrival of the missing materials.

In essence, the catalytic-cracker model greatly simplified the company's war program by closing the gap which threatened to separate the main office staff from the field. It furnished a kind of daily contact with the physical reality of the job, even within the walls of a city skyscraper.

The successful performance reported from each of the fluid catalyst units as they go on stream is due to considerable measure to the application of scale models to the company's wartime task.

Consulting Chemists' Directory Issued

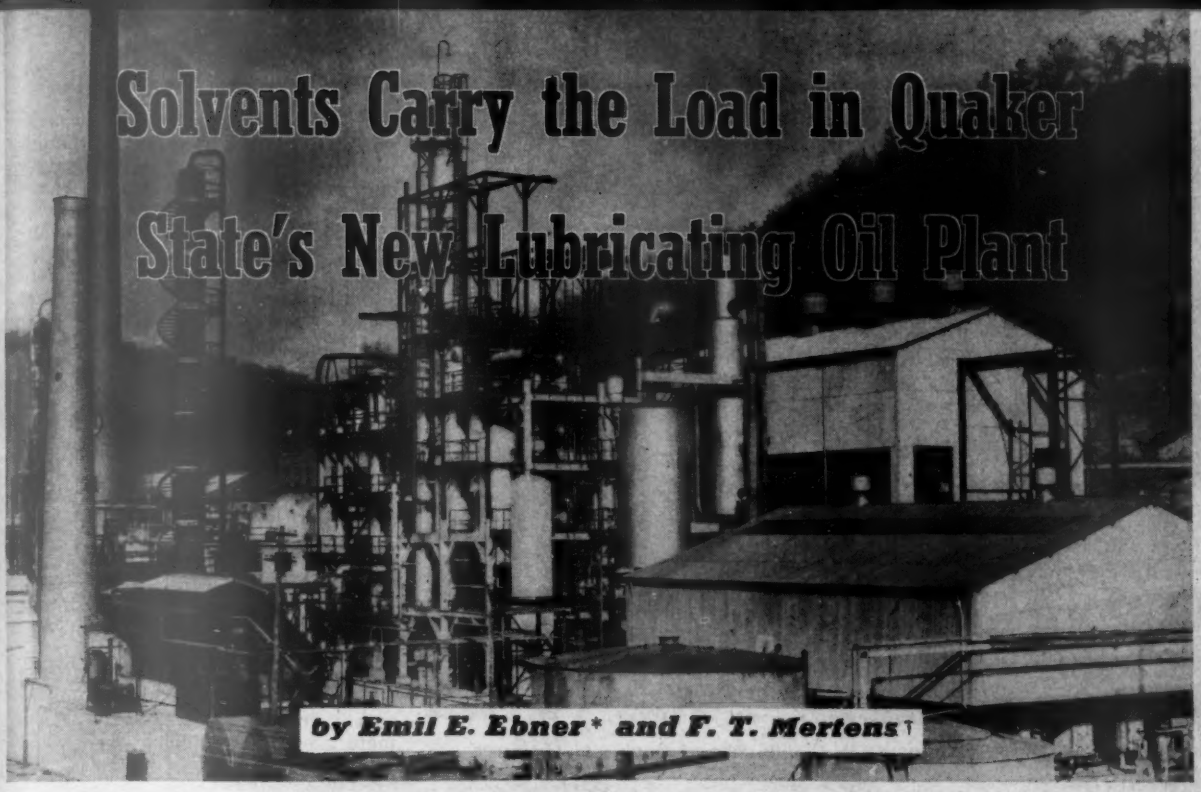
A 96-page booklet listing the names and specialties of a large number of American consulting chemists and chemical engineers has just been issued by the Association of Consulting Chemists and Chemical Engineers, Inc., at 50 East Forty-first Street, New York 17. The list includes brief resumes of members' background, experiences and fields of endeavor, alphabetical membership index, company affiliations and geographical locations. The directory may be obtained without charge at the above address.

Glossary of Synthetic-Rubber Terms

A Glossary of Terms in Synthetic Rubber, a booklet of eight pages, has been compiled by Hycar Chemical Co., and may be obtained by writing that company, 335 South Main Street, Akron, Ohio. The list of terms is by no means complete for this very new and rapidly expanding vocabulary and includes only the well-established trade names and the more common chemical terms. Inquiries may be addressed to John A. Tallant, manager, Technical Data Service.

Solvents Carry the Load in Quaker State's New Lubricating Oil Plant

by Emil E. Ebner* and F. T. Mertens†



General plant view—Furfural refining and solvent dewaxing units

THE Quaker State Oil Refining Corp. recently placed in operation at its Emlenton, Pa., refinery a new lubricating oil and wax plant for the production of low pour point, high viscosity index motor, heavy duty and aviation oils, and for the manufacture of high purity, oil free crystalline and micro-crystalline waxes.

The capacity of the clay percolation plant was also increased by the addition of another clay regenerating furnace to increase the output of low carbon residue bright stocks and of light colored grades of micro-crystalline waxes.

The new plant consists of Methyl Ethyl Ketone-Benzol solvent dewaxing and wax recrystallizing units and a Furfural solvent extraction unit.

The MEK-Benzol solvent plant is designed to permit simultaneous dewaxing of raw lubricating oil fractions from Pennsylvania crude into finished low pour point oils, and recrystallizing of crude waxes into finished deoiled and fractionated waxes in a wide variety of melting points. This simultaneous operational feature is unique and the installation of the Quaker State Emlenton refinery is the first of its kind to be so constructed.

Quaker State engineers worked out the design of the solvent dewaxing and recrystallizing plant with Texaco Development Corp., which licenses the processes, and Foster Wheeler Corp. was awarded the contract for the detailed design and construction of the unit.

The design and operation of the wax deoiling and recrystallizing sections of the new plant were evolved from several years of laboratory research and development on improved methods for wax deoiling, fractional recrystallization and purification. The earlier phases of this laboratory work led to the construction in 1936 of an MEK-Benzol dewaxing plant at the McKean refinery of Quaker State. This was the first commercial application of Ketone-Benzol solvent dewaxing and deoiling in the Pennsylvania refining area. While this earlier plant was primarily intended for dewaxing and deoiling, it was also used for full scale recrystallization and purification of waxes, following procedures developed in the laboratory. These full scale trials in 1936 through 1939 confirmed the laboratory work that the Ketone-Benzol solvent process could be utilized to produce closely fractionated waxes of very low oil content with much greater efficiency and precision than was possible by the conventional methods of sweating, repressing or multiple-centrifuging.

The Furfural solvent extraction unit of the new plant follows the same general design as two similar units which were installed at the McKean and St. Mary's refineries of Quaker State in 1938-39. Extensive research in the Quaker State process and engine laboratories had demonstrated

EMIL E. EBNER

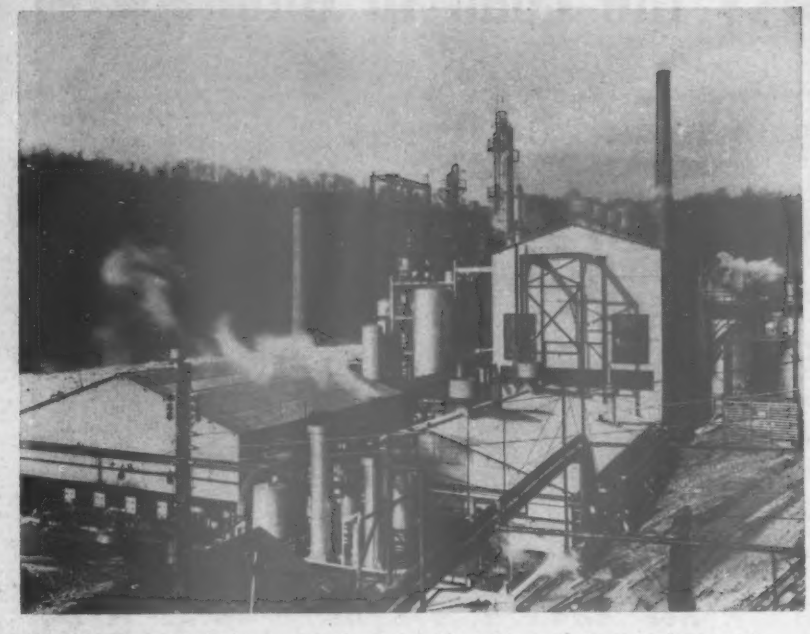
F. T. MERTENS

Emil E. Ebner, general superintendent of refineries, is a native of Kansas and attended University of Illinois, where he studied electrical engineering and later attended University of Michigan, where he obtained his bachelor of science degree in chemical engineering. He formerly worked for Southwestern Bell Telephone Co., E. B. Badger & Sons Co., and White Star Refining Co. (Detroit), before becoming associated with Quaker State Oil Refining Corp., where he also directs the research, process and engineering activities of the corporation.

Frederick T. Mertens is a native of New Jersey and attended Cooper Union Institute of Technology, where he received a degree of bachelor of science in chemical engineering. He formerly worked with Sinclair Refining Co. and Tide Water Associated Oil Co. before becoming associated with Foster Wheeler Corp., where he is in charge of lubricating oil plant design.

*General superintendent of refineries, Quaker State Oil & Refining Corp.

†Process engineer, Foster Wheeler Corp.



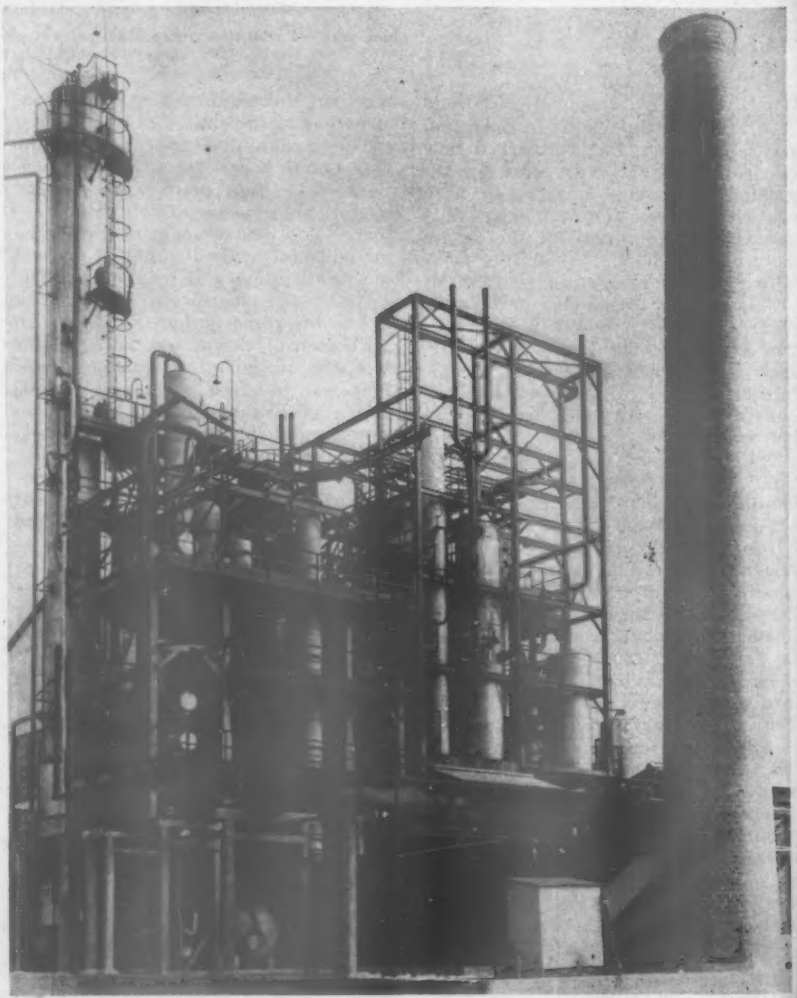
Dewaxing unit looking north showing refrigeration condensers in foreground

that motor and aero oils refined by conventional methods of distillation and clay treatment still retained small concentrations of unstable constituents which, on exposure to elevated temperatures and aeration in engines, oxidized readily with formation of sludges and varnishlike deposits. Solvent extraction was found to be the only precise means of removing these readily oxidizable constituents to produce highly sludge and varnish resistant engine lubricating oils. The success of the first two Furfural solvent extraction plants at the McKean and St. Mary's refineries in accomplishing this objective led to the third installation at the Emlenton refinery.

Detailed Studies Prepared

After the basic features of the new plant were decided upon by the Quaker State engineering department, Foster Wheeler Corp. was requested to prepare numerous detailed studies as to the most economic design. These included studies of fired heaters versus steam for the solvent recovery systems and of the types of drives most suited for the numerous pumps and refrigeration compressors. After making utilities balances on several types of operation, the decision was made to install a new high pressure steam generating plant with provision for the possible future installation of an electric power generating unit. Considerable study and planning was also required on the arrangement of the new plant equipment in the available site which was on a quite restricted strip of land between a hillside and the Allegheny River.

While the final engineering and design work in the new plant was in progress, war was declared. Although the need for high quality heavy duty and aviation oils and special waxes was recognized, the greater immediate demand on the petroleum industry was for 100-octane gasoline, toluene, and butadiene. The priority situation accordingly demanded that every effort be made to utilize second-hand or reconstructed equipment wherever possible. Fortunately, Quaker State had some time previously purchased the solvent dewaxing plant of a refinery in process of liquidation. After considerable study, it was found possible to recondition and utilize the major portion of this old plant in the new construction program. Considerable of the tankage and miscellaneous equipment for the new plant was also secured by salvage and relocation of many items from other of the Quaker State refineries. This extensive program of salvage and conversion of existing equipment resulted in the saving of several hundred tons of critical new materials and equipment.



Treating tower and recovery systems for Furfural and dewaxing units

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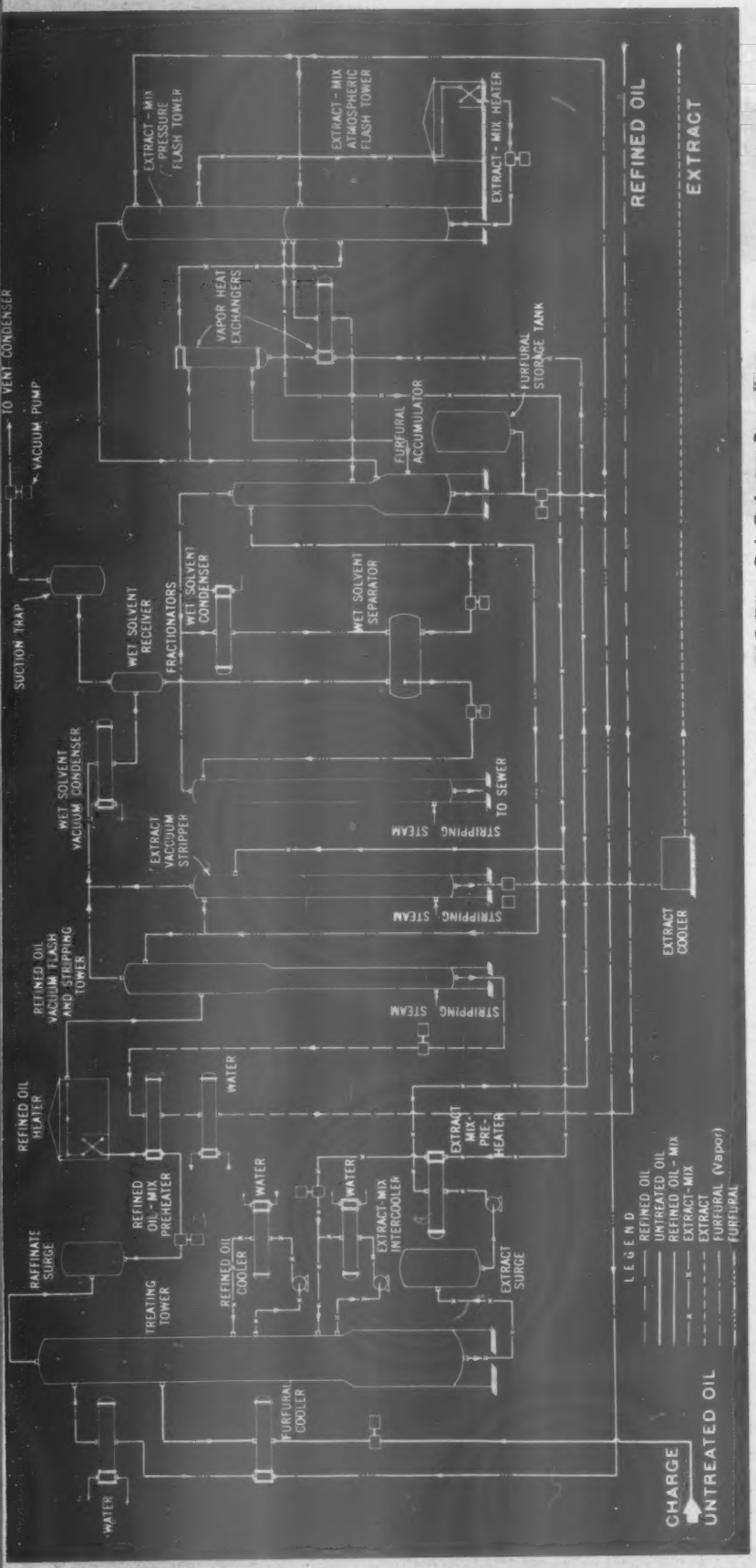

Simplified flowchart of Furfural extraction unit, at Quaker State Oil Refining Co.'s Emlenton, Pa., refinery

Referring to the simplified flow diagram, it will be noted that the new dewaxing and recrystallization wax plant comprises seven major sections:

1. Direct expansion ammonia chilling.
2. Double pipe scraped surface exchangers and chillers for both the solvent dewaxing and the wax recrystallizing process sections.
3. Continuous vacuum dewaxing filters.
4. Tubular exchangers and chillers to chill wash solvent.
5. Flue gas generation, circulation and chilling.
6. Four complete product recovery systems for (a) dewaxed oil, (b) slack wax, (c) slop wax filtrate, (d) product wax.
7. Solvent water separating and recovery system.

The solvent dewaxing and wax recrystallization process section is essentially two separate units which may be operated in series or in parallel flow. Several combinations of operations may accordingly be carried out. Reduced wax distillate can be charged to the dewaxing unit to produce a neutral oil of —10° F. pour point. (This dewaxed neutral is subsequently extracted in the Furfural refining process unit to yield a lubricating oil having a viscosity index of 110 to 115.) The "slack wax" from the dewaxing operation, averaging 125° F. melting point and containing about 6 per cent oil, is simultaneously charged to the recrystallizing unit with additional solvent where at a filtering temperature of 30° F. it is deoiled to yield crystalline wax having a melting point of 130°-132° F. A.m.p. and an A.S.T.M. oil content of well under 1 per cent. As an alternate operation, Pennsylvania cylinder stock may be dewaxed to 0° F. pour point yielding a petrolatum of about 128° F. m.p. with about 8 per cent oil content. This petrolatum may then be recrystallized with additional solvent at a temperature of 60° F., yielding a micro-crystalline wax of a high melting point and an oil content of 0.5 per cent or less.

The solvent dewaxing and recrystallization units are sufficiently flexible that cylinder stock can be dewaxed in the dewaxing unit while paraffin slack wax can be charged to the recrystallizing unit for production of finished crystalline waxes. Alternately, it is possible to process neutral oil in the dewaxing unit and at the same time to recrystallize crude petrolatum to yield microcrystalline type waxes.

By selective control of solvent ratios and chilling temperatures it is possible to produce neutral oils having pour points from +25° F. to as low as —30° F., and viscous stocks having pour points from +25° F. to as low as —20° F. Similarly, crude par-

affin waxes can be solvent fractionated to yield oil free crystalline waxes having melting points as low as 110° F. and as high as 140° F. Petrolatum can be recrystallized and fractionated to yield micro-crystalline type waxes with melting points ranging from 110° F. up to 160° F. or higher.

The solvent dewaxing unit of the plant has a designed capacity of 1,000 to 1,500 bbl. per stream day depending upon the type of charge stock and the pour point to be produced. The wax recrystallization section has a designed capacity of 200 to 275 bbl. per stream day, depending upon the type of crude wax charge and the type of product wax desired.

Plant Operating Data

Average plant operating data are shown in Table 1.

The flow through the dewaxing unit is essentially as follows: The charge oil is mixed with solvent, the ratio depending upon the viscosity of the charge oil, and held constant by a ratio flow recording controller. The mixture is first cooled by water in a shell and tube exchanger and then by cold dewaxed oil filtrate in several double pipe type exchangers. The partially cooled mixture passes through the inner pipe of the exchangers, wherein revolving spring-loaded scrapers keep the surface free of wax accumulation thereby assuring constant high heat transfer rates. The charge mix is finally chilled to the desired filtering temperature by the use of direct expanding ammonia in additional double pipe, scraped surface chillers. The cold mix containing the crystallized waxes then passes to a gravity flow filter feed tank where the amount of charge admitted to each filter is controlled by liquid level instruments operating butterfly type valves.

The liquid oil passes through the filter cloth of the revolving filter drums and is subsequently pumped from the filtrate receiver through the previously mentioned double pipe exchangers, whereby considerable refrigeration is recovered, and then passes to a surge tank before it is charged to the solvent recovery system.

Wax Cake Continuously Washed

The wax cake, commonly called "slack wax," collects on the surface of the revolving drums of the vacuum dewaxing filters, where it is continuously washed with cold solvent to displace oil held in the interstices of the wax crystals. The washed wax cake is continuously removed from the filter drums and pumped, by means of a reciprocating steam pump, through a heat exchanger where some refrigeration is recovered by transfer to incoming wash solvent. The wax cake is then heated by exhaust steam to a completely liq-

TABLE 1

	Reduced wax distillate	Extracted and filtered cylinder stock
Charge oil:		
A.P.I. gravity	32.7	27.7
S.S.U. viscosity	152 at 100° F.	136 at 210° F.
Pour point, °F.	90	70
P.M. flash	430	530
Dewaxed oil:		
Yield per cent by volume	79	80
A.P.I. gravity	30.4	27.2
S.S.U. viscosity	195 at 100° F.	146 at 210° F.
P.M. flash	435	535
Pour point	0 to 1.5° F.	10° to 15° F.
Color	3D NPA	2 TR
Carbon	.....	0.95 per cent
Slack wax:		
P.M. flash	430	520
Melting point (A.S.T.M.)	126.5	129
Per cent oil content	6.5	8.0

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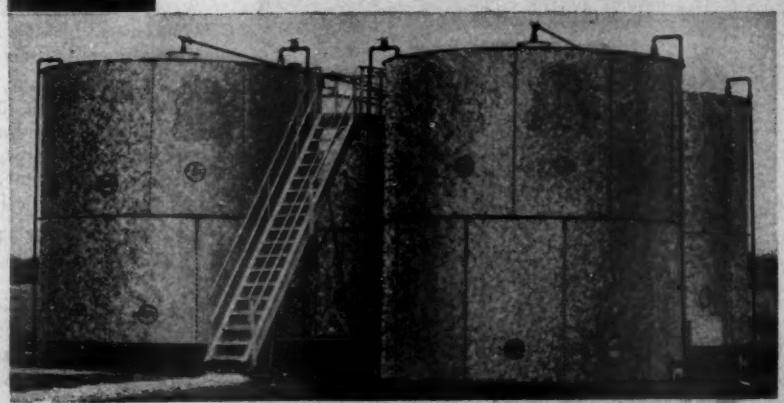

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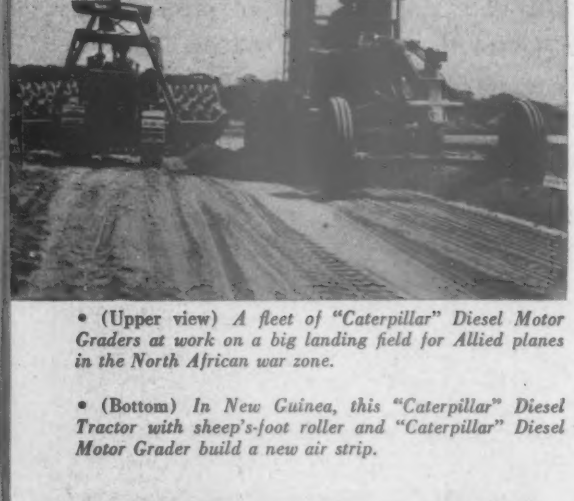

• (Upper view) *A fleet of "Caterpillar" Diesel Motor Graders at work on a big landing field for Allied planes in the North African war zone.*

• (Bottom) *In New Guinea, this "Caterpillar" Diesel Tractor with sheep's-foot roller and "Caterpillar" Diesel Motor Grader build a new air strip.*

"Toughest motor grader on earth!" . . . That's the way contractors and county officials have always talked about their "Caterpillar" Diesel Motor Graders. That's the way men in the armed forces talk about them today. For these rugged machines have proved themselves as versatile and dependable on the battle fronts as they ever did on construction and maintenance jobs at home.

"Caterpillar" is building them now at the greatest production rate in history. But motor graders are so vitally needed by fighting men that only a small fraction of the increased output can be spared for use elsewhere. And those few machines are allocated by the War Production Board to purchasers in war-essential work.

If it comes to a choice between repairing your local roads or rushing through an emergency landing field for hard-pressed Yank airmen, there can be no argument. We've got to win the war.

However, there's a brighter side. This same huge "Caterpillar" production will be available for civilian needs as soon as war and government regulations permit. There'll be no time out for retooling. The machines you get will be war-tested — up to the minute in every detail. They'll have the same unfailing power and traction, same ease of handling, same wide range of blade positions that have always made "Caterpillar" Diesel Motor Graders first choice.

In the meantime, many who need "Caterpillar" Diesel Motor Graders must wait for peace. Do your best to keep your present equipment going. Enlist the "Fighting Four" (Inspect, Lubricate, Adjust and Replace) for the duration. And if you reach the point where you must have a new machine, talk to your "Caterpillar" dealer. He will gladly explain how you can apply for it.

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TO WIN THE WAR: WORK—FIGHT—BUY U. S. WAR BONDS!

uid state to aid in settling out in the surge tank any moisture that may have entered the filtering system.

The slack wax mix may then be either charged to the recovery system for removal of the solvent or may be charged to the wax recrystallization unit for deoiling and fractionating. If the latter operation is followed, the wax is mixed with additional solvent to the desired dilution, cooled in a shell and tube heat exchanger with water, and finally chilled in a double pipe heat exchanger to the desired filtering temperature. The filtering temperature varies from +25° F. to +60° F., depending upon whether the slack wax is of a crystalline or amorphous character and also upon the desired final melting point of the product wax. The chilled wax mix is then processed through the recrystallizing unit in a manner similar to that already described for the dewaxing unit. The filtrate containing the oily and undesirable low melting point portion of the slack wax that has passed through the filter cloth is used to precool some of the wash solvent before being charged to the recovery section for removal of solvent. The product wax cake is heated to approximately 150° F. with exhaust steam to liquefy the wax before it is run through the recovery system.

Heat Economy Achieved

The four recovery systems use live and exhaust steam for the removal of solvent. The dewaxed oil filtrate is preheated by solvent vapor and by countercurrent stripped dewaxed oil before being flashed at atmospheric pressure. In order to obtain maximum heat economy, a system of double effect evaporation, as illustrated on the flow diagram, is employed. Steam stripping is used for removal of final traces of the dewaxing solvent.

The other three recovery systems for the slack wax, the product wax and the oily or "slop wax" filtrate, use exhaust steam to evaporate off 75-80 per cent of the solvent and then follow with live steam reboiling to remove essentially all of the remaining solvent before final steam stripping of each stream. In these three sections, the evaporation is all carried out at atmospheric pressure since the quantities of solvent handled are not sufficiently large to justify a double effect evaporating system. Since the flowing quantities of either of these three streams are relatively small, finned tube heaters are used, heated with live steam, to aid in maintaining satisfactory temperatures at the base of the stripping columns. The net flow of product from the base of the stripper is level controlled to storage, and pressure governors are used to aid in maintaining circu-

TABLE 2

	Dewaxed neutral oil	Raw cylinder stock
Charge oil:		
A.P.I. gravity	30.4	26.0
S.S.U. viscosity	195 at 100° F.	161 at 210° F.
P.M. flash	430	525
Per cent furfural applied by volume	159	160
Treating-tower temperatures:		
Top, °F.	235	275
Feed tray, °F.	199	216
Bottom, °F.	134	179
Refined-oil yield, volume per cent	92.0	94.0
Refined oil:		
A.P.I. gravity	32.9	27.3
S.S.U. viscosity	172 at 100° F.	151 at 210° F.
P.M. flash	430	535
Viscosity index	113	105
Extract:		
A.P.I. gravity	7.8	5.8
S.S.U. viscosity	85 at 210° F.	3,100 at 210° F.

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In the near future, LaPlant-Choate will announce a complete new line of cable and hydraulic operated dozers and scrapers, built exclusively for all sizes of "Caterpillar" track-type and rubber-tired tractors. These new LaPlant-Choate outfits will offer improvements never before dreamed of in the earthmoving industry—so be sure to see them before you buy any new equipment.

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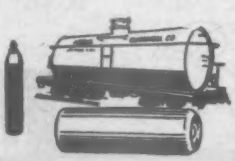

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TWENTY-NINE YEARS OF KNOWING HOW

lation of the stripper bottoms back through the reheaters.

The Furfural refining unit is quite similar to the two units that were previously designed and constructed by Foster Wheeler for Quaker State in 1938-39. The main improvement has been in the design of the extraction tower in order to reduce the quantity of furfural required to yield the desired quality of product. This new tower is the first one of its kind installed and is the outgrowth of a study undertaken by the engineers of Texaco Development Corp., Quaker State and the Foster Wheeler Corp.

Even Distribution of Solvent

The tower contains eight nests of Raschig rings, each 5 ft. in depth, with specially designed trays above each nest to assure even distribution of the downflowing solvent, without interfering with the upflowing refined oil or raffinate stream. By the use of two intercoolers to cool the descending stream of extract mix as desired, and regulation of the temperatures of the charge oil and treating solvent, a very even temperature gradient is maintained throughout the tower. It is possible to vary at will the temperature in any part of the treating tower to obtain optimum results for any particular charge stock.

The untreated oil is preheated to the desired temperature by either hot furfural or exhaust steam and charged to the middle of the treating section of the extraction tower. The furfural at a temperature ranging from 200° to 300° F., depending upon the stock being refined, is introduced just above the top nest of Raschig rings. The furfural flows downward through the oil filled packing countercurrent to the ascending stream of charge.

The raffinate, together with a small quantity of solvent, flows from the top of the extraction column to a surge tank. The mix is pumped (controlled by a rate of flow controller) through a heat exchanger and direct fired heater to the vacuum flash and stripping column where all traces of furfural are removed from the refined oil.

The extract solution, containing most of the furfural solvent, flows from the bottom of the settling section of the treating tower to a surge tank before being charged to the recovery section. Since fuel costs are quite high, a double effect evaporation system is employed, together with a final steam stripper.

The Furfural extraction unit was designed to charge from 1,000 to 1,750 b.p.s.d. depending upon the type of charge stock and the degree of extraction desired. Table 2 shows typical results of 10-day trial runs.

The plant was brought on stream in late September and after the usual "tuning up" period has been operating with complete satisfaction both as to quality of product and capacity.

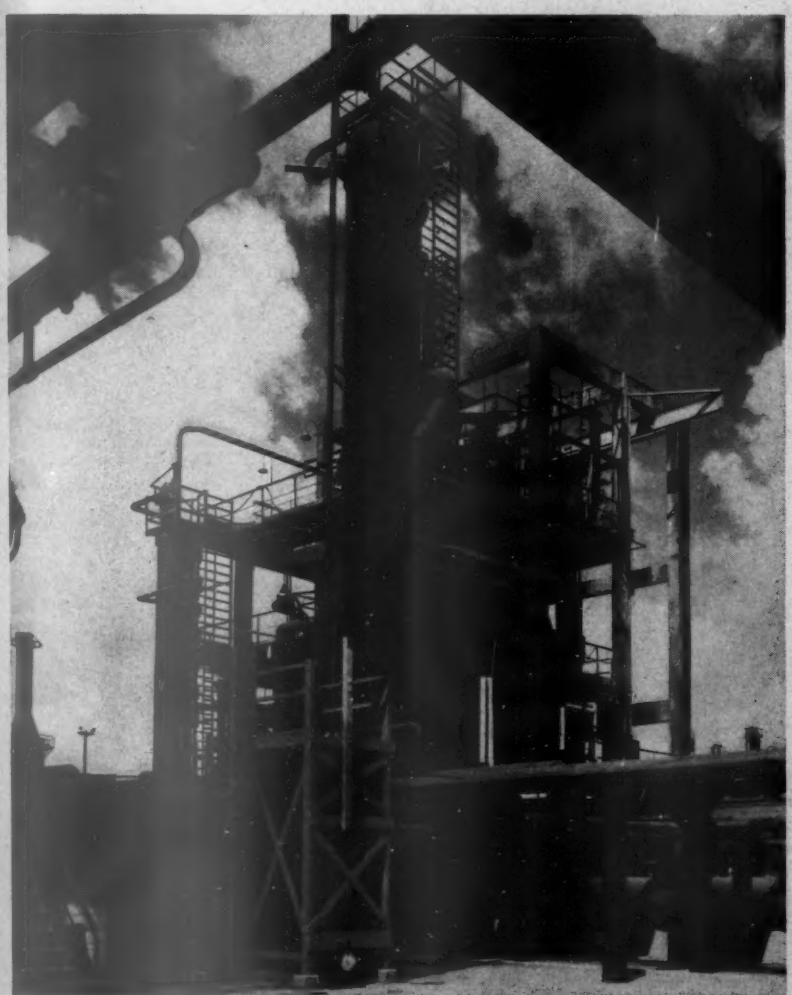
How One Company's Whole Refining Capacity Was Turned to War

The Baytown, Tex., refinery of Humble Oil & Refining Co. is in the vanguard of plants producing critical petroleum war products. Here is the story of the conversion.

THE frightful picture of Germany overrunning European countries with vast armadas of war machines brought to the American petroleum industry the realization that immediate expansion was necessary to meet the unprecedented demand for oil and oil products which America would need if it became involved in the war.

Fortunately, the endless research which the industry carries on served as a tremendously important prop to steady it in those first uncertain days after Pearl Harbor. Processes for the manufacture of synthetic toluene and high-octane aviation gasoline in great quantities had already been perfected, and synthetic rubber from petroleum was about to emerge from the laboratory.

Fortunately, also, some of the leading refiners had giant new units in the blue-print stage and were in position to convert many existing facilities into the new and accelerated war duction program. Among the companies thus favorably situated, Humble Oil & Refining Co. is particularly noteworthy.



Fractionating equipment on extraction unit of butadiene plant at Baytown, Tex.

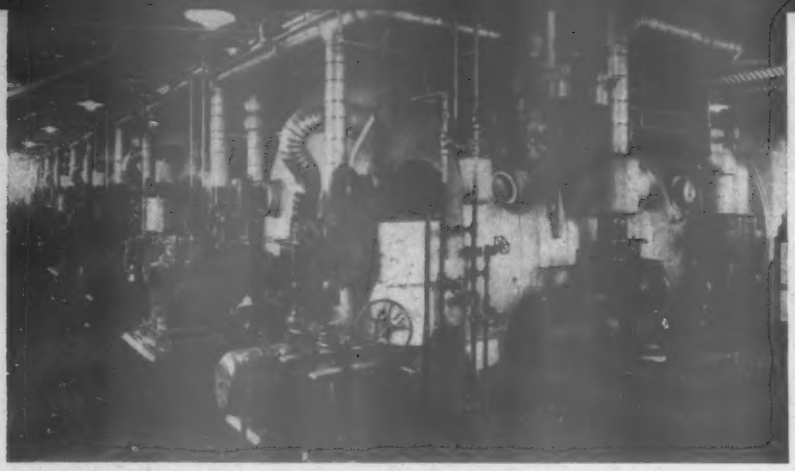
As early as 1937, Humble added facilities at Baytown for the increased production of high-quality motor gasoline. A unique 200-mile pipe line was built to bring a commingled stock of natural gasoline and butane from the East Texas field to Baytown for fractionation and processing at the thermal-polymerization unit built at the same time. Today these are vital war facilities, since even before the war, the combination of these two has been used for aviation gasoline and has played an important part in Humble's production of high-octane aviation gasoline.

In 1937, Humble also built at Baytown phenol and propane treating plants to increase the output of high-quality motor oils. Today those units are playing a vital role in the company's quantity production of aviation engine oils.

In 1938, a cold-acid treating plant was converted into the world's first commercial alkylation plant, a unit which even before Pearl Harbor placed the company in an enviable position in the 100-octane gasoline production program.

As the war clouds darkened, Humble signed a contract in 1940 to erect and operate Baytown Ordnance Works. This tremendously important plant began producing nitration-grade toluene 45 days before Pearl Harbor and for many months was the backbone of America's production of wartime explosives. For having produced toluene at double the contract rate for more than 2 years this plant has been awarded the Army-Navy E flag and two stars.

Shortly after Baytown Ordnance Works was completed, Humble undertook an expansion program involving government and company funds, which has brought about a vast change in Baytown refinery's skyline. Units which have been added since the outbreak of the war include two company-owned fluid-catalytic-cracking units, company-owned superfractionation equipment, a government-financed 30,000-ton-a-year butadiene plant, in operation since August 1943



Filter drums in the Baytown propane plant, from which high-quality engine oils flow

and now producing at rated capacity, and a butyl rubber plant now nearing completion.

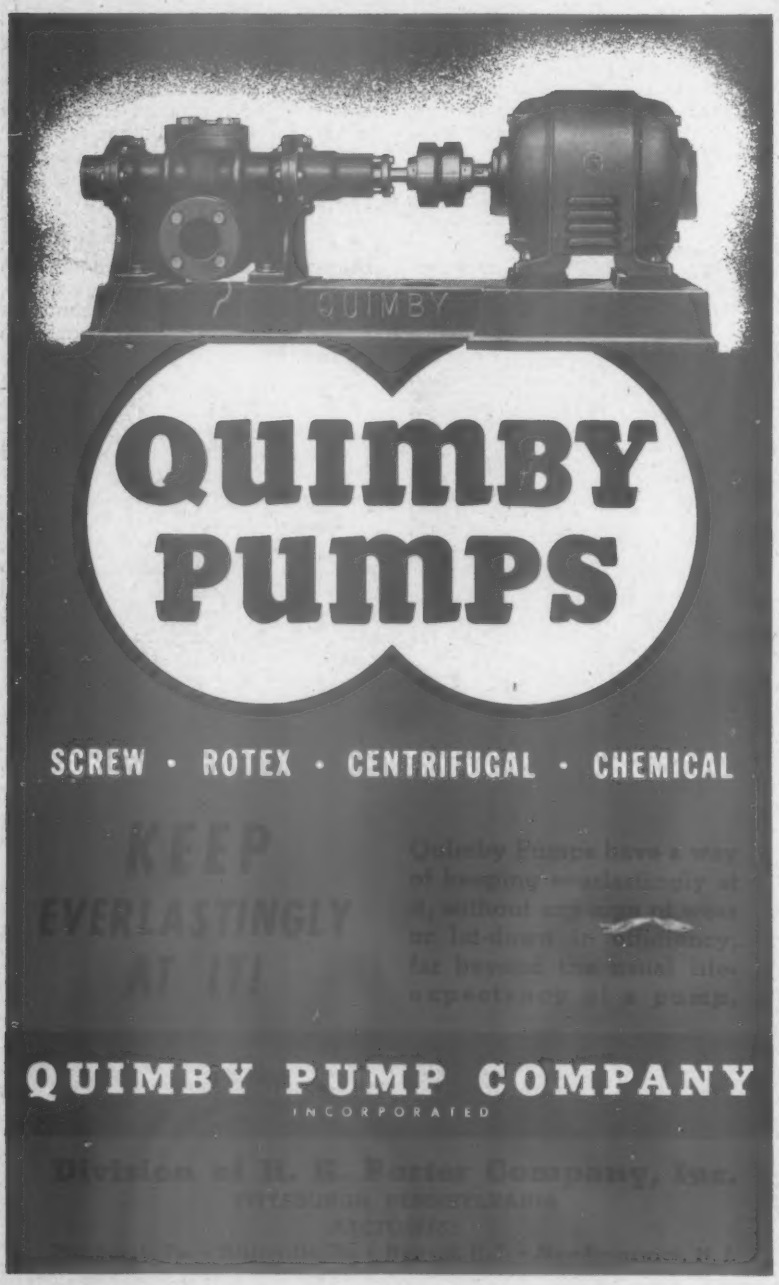
Conversion of old units to help increase the output of aviation gasoline and components, toluene and other war products includes reconstruction of a viscosity-breaking unit into a rerun unit for 100-octane components; conversion of a pipe still to a naphtha rerun unit for the production of a feed stock suitable for toluene processing; conversion of old equipment into a butane isomerization unit to aid in the alkylation production program, and remodeling of two old cracking units into low-pressure hydrogenation equipment.

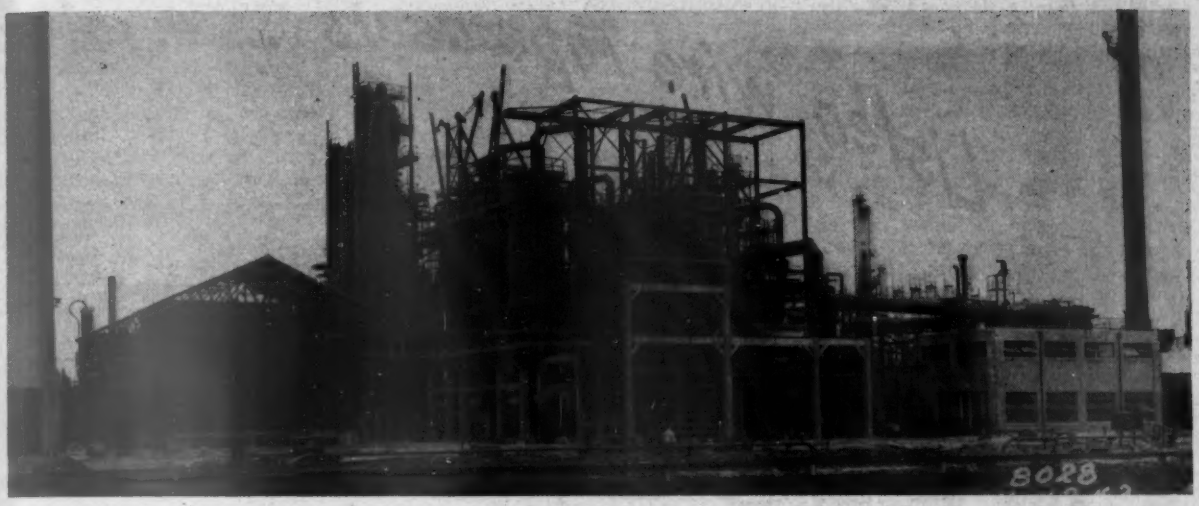
At the company's Ingleside refinery a conversion program for production of butadiene was undertaken in 1943 to bring that plant into the synthetic-rubber picture. Cracking coils were remodeled to become a manufacturing unit; a gas plant was transformed into a recovery and fractionation unit; and an extraction unit was constructed largely with second-hand material. All of this juggling and modernization of old equipment resulted in a plant with a capacity of 12,500 tons of butadiene a year, which has been in operation for some time.

In many cases, Humble technologists and mechanical craftsmen were harried by shortages of material and equipment and were forced to solve their problems as best they could. For instance, air compressors were made to serve where gas compressors were needed; pump impellers were trimmed to reduce the pressure for new operating conditions; and to overcome the lack of stainless-steel pump pistons, ordinary pistons have been converted by spraying on them a thin coat of stainless steel. For another type of service, pump plungers have been coated with glass, a process which may become a commercial reality after the war.

What the conversion and construction program has done for Humble's Baytown and Ingleside refineries cannot be told entirely. Suffice to say that in spite of the fact that the products coming from the two plants today are much more highly processed than were those of prewar days, the volume of throughput has increased materially, and Baytown refinery is in the vanguard of plants producing critical petroleum war products.

While the construction and conversion program was being rushed to completion the technical and research branch has accelerated operations in a parallel manner. New ways to improve war products and simplify their production in greater quantities are being studied constantly in the research and test laboratories and pilot plants.





Houdry catalytic-cracking unit at Port Arthur, Tex., refinery of Gulf Oil Corp., now making base stock for aviation fuel

Economy of Crude, Efficiency of Refining Processes Keynote of Postwar Industry

by Arch L. Foster

PROGNOSTICATION in 1944 of the conditions which will obtain in the refining industry postwar can be made with confidence only if all controlling factors are known and are evaluated with exactness. Practically all these factors are known, qualitatively; practically none of them are known quantitatively, nor can they be evaluated with any of the engineer's idea of exactness. The best "look-see" which can be had is to assume a set of conditions which may exist postwar, conditions which appear to agree most closely with the expectable situation, from our present viewpoint. If this assumed set of conditions materializes after the war as predicated, then the deductions from them should prophesy approximately the postwar prospects. If assumptions are in error then the results will be correspondingly farther afield.

The most controlling known fact now is that we are discovering less crude than is needed to replace our consumption and the steady depletion of reserves in known fields. Immediately this reverses the position of the refiner compared to his situation since the early 1920's. Since the period immediately following World War I, when crude prices rose to 3 dollars and higher, our crude production has been extravagant. Our refining economy has largely operated on a basis of a surplus of crude. Processing has been directed solely to the production of commercial products to meet a seller's market.

Under a reduced crude-supply regime this situation is reversed. It becomes imperative to conserve each gallon of crude; to produce the largest practicable quantities of the highest-priced, most economical product which can be made. It becomes imperative that as small a portion of that gallon as possible be destroyed or degraded in making these important products. Recently it was mentioned that, whereas in 1924 about 1 gal. of crude was consumed from each 42-gal. barrel in the refining process, now 5 to 6 gal. of the same barrel are destroyed in making our 45 per cent of motor fuel, with other less important products. Such a system cannot be tolerated under a dwindling crude-supply situation. Better to make poorer gasoline and have enough for our national needs, than to produce a premium-quality fuel and not have sufficient supply to go round, say practical executives.

Dwindling crude supplies and potential ultimate production is forcing refiners to look to yields of the most profitable and required products more than ever. Waste of raw material becomes less and less permissible. Gasoline demand estimates place our 1946 consumption at 650,000,000 bbl. of motor fuel; for 1950, 860,000,000 bbl.

Increased price margins postwar will be required to permit the refiner to use more costly crude, more expensive processes to make products of the required properties.

Catalytic cracking will show higher yields of salable gas oils, furnace oil and intermediate distillate fractions with comparable or higher motor fuel yields and much lower heavy, low-priced residual fuels yields.

Various authorities have made estimates of the number of cars, barrels of gasoline and other commodities which will be required by the nation after the war and whatever the exact figures indicated for any given requirement, all are agreed that demands and production alike will increase. One of the most complete estimates is that of C. L. Burrill as reported to the A.I.M.E. recently.[1] Burrill estimates our total gasoline demand for 1946 to be 650,000,000 bbl.,

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for 1950, it is 862,500,000 bbl. These figures are based on the assumption that the war will be over in Europe in 1944, and in the East by 1945. These two figures include 29,500,000 bbl. export gasoline in 1946, and 12,500,000 bbl. in 1950.

Burrill further estimates that the first full year of peace will see 3½ million cars produced, with 5,500,000 built each year thereafter, peak production of cars, trucks, etc., being reached within 3 years after peace is declared. In 1944 he says nearly 24,000,000 cars, 142,000 buses and 4,454,000 trucks will be in service. In 1950 these figures will jump to nearly 52,000,000 cars, 5,741,000 trucks and 166,000 buses. Other estimates have been made which indicate that if peace is postponed beyond the years used in these studies the peaks of production and use will be correspondingly postponed, possibly for a greater delay period than will be the case if peace comes in Europe this year.

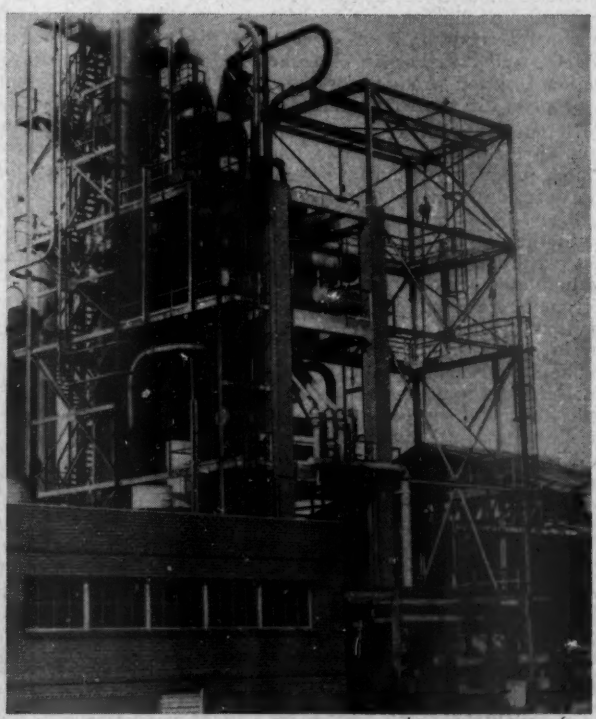
Under our present system prices are held down arbitrarily, by dictatorial fiat, fostered and excused by the demands of war. Under such conditions not enough inducement is offered to stimulate exploration to discover the needed new crude. Always heretofore a recession in crude supplies has primed exploration to find adequate additional amounts and to give us the surfeit we have experienced these last 20 years. However, if we are to expect a resumption of private enterprise postwar then inevitably competition will force the prices of crude and therefore of refined products upward until a balance between them is reached. This increase in production and balance in cost vs. prices cannot be attained instantly. It will doubtless require 3 to 5 years to reach such an equilibrium and to uncover enough new crude to supply our needs. There is in fact no guaranty that we shall experience even within that time the crude-in-plenty supply enjoyed in past decades. Whatever the ultimate development, it is the conditions obtaining during that lean postwar period of readjustment that are of most concern to us now; the methods for meeting that situation are those which must be perfected first, before that emergency arises, if possible.

Prices Will Be Higher

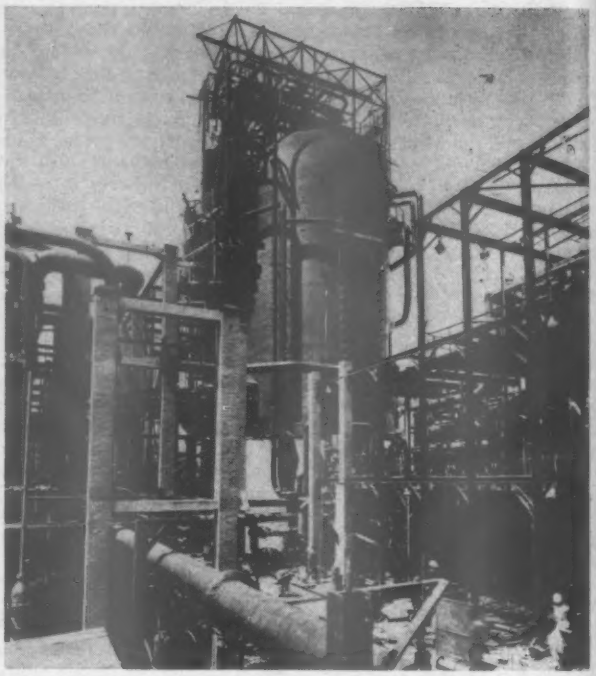
It suffices to say now, we believe, that prices of both crude and refined products will be considerably higher postwar than they have been during the last 2 decades. With a wider margin of returns the refiner may be able to justify and to pay for operating processes and methods which could not be justified under prewar prices. Prior to the current war our most important product, motor fuel, sold at the refinery at from 4 to 6 cents per gallon, a condition which continued for more than a decade with little variation. Thinking in terms of these prices and of the immense sums currently invested in war-justified catalytic-cracking units makes it obvious at a glance that this type of process as we know it now is not possible for the average refiner meeting a highly competitive market.

But what may follow if we sell the product at 8 cents or 10 cents f.o.b. the refinery? A margin of even 3 cents for the refiner to cover costs, even though one-half or two-thirds of this amount goes for the higher crude price will give him ample grounds for higher expenditures for refining processes and its operation, if the resulting products enable him to meet the demands of the market. A strong rise in prices of both crude and its refined products as soon as war-born artificial controls are removed, is clearly indicated.

Under these conditions it may be certain that the adoption of these more modern processes of catalytic cracking, alkylation, isomerization, improved methods for lubricating-oil refining will be excused and justified by an economy of higher prices for all products. Heretofore gasoline was the major product sold for more than the price of the same volume of crude. Diesel fuels, kerosenes, furnace oils and possibly some other products sold for more than was paid for equivalent crude volumes, but their individual volume was a smaller part of the total. Residual fuel oil, ranging



Left: Steel requirements per barrel of petroleum product continue to increase as the complexity of refining units increases. Here is a labyrinth of vessels and piping in Union Oil Co. of California's aviation-fuel unit. Right: This naphtha polyform unit charges 2,700 bbl. per day of straightrun naphtha and 100 bbl. per day of propane-butane to make approximately 2,500 bbl. per day of high-octane-number polyform motor or aviation-fuel base



Left: Superfractionation is a large part of the operation of alkylation units, segregating both charge stocks and products. This unit of The Texas Co. is producing alkylate for aviation fuel. Right: Correspondingly, sizes of equipment are increasing; here is a recently built 33-ft. diameter vacuum tower

from 10 per cent to 40 per cent of the crude barrel, was sold at a loss. Increases in gasoline and premium price products must come, in future, at the expense of the production of these cheap materials. It is an economy of waste which makes it necessary to sell a finished product for less than was paid for the raw material.

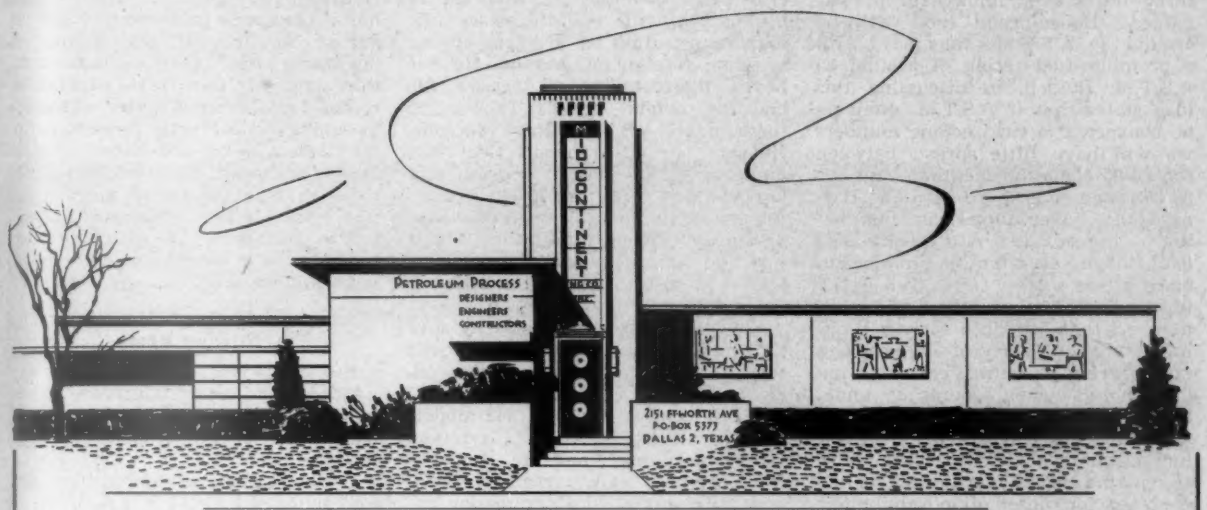
It may well be, therefore, that the high price levels for crude and refined products which are expected postwar will enable the refiner to utilize these new processes along with the old proven methods to produce a greater percentage of the most valuable petroleum materials. Our foremost refining technologists tell us that, generally speaking, the recycle stocks from catalytic cracking make better charge stocks for thermal cracking, and in considerable degree thermal recycle oils are cracked best by catalytic methods. Processes are in course of commercial development, we understand, wherein a combination of these two methods, along with other new and old auxiliary processes, will show yields of motor fuel and/or aviation fuel well above the 50 to 70 per cent maximum yields of other years, with a correspondingly smaller percentage of crude degraded below the price of the original crude.

Shortage of crude, demanding maximum yields, may find a ready aide in such processes as alkylation and isomerization. Alkylation increases the over-all yield from crude by utilizing the light natural-gas constituents of propane, butanes, pentanes, etc. Isomerization converts nonreactive normal butane and pentane to isomers which take part in the alkylation reaction, further increasing the over-all yield per unit of crude. Thermal cracking forms large quantities of C_3, C_4 and C_5 olefins, some retained in motor fuel as such, others wasted under prewar operations, but all of which may be converted to saturated hydrocarbons of higher-octane rating by alkylation with isoparaffins. Isomers are produced in large quantities, along with some olefins, in catalytic cracking. Combining isomerized paraffins from catalytic crackers with those from some isomerization processing, and alkylating them with olefins from the parallel thermal cracker can increase the total gasoline yield from 4 to 8 per cent, we are told.

Rehabilitation of Refining Technology to Be Gradual

It is probable, however, that the more widespread adoption of these newer processing methods will be comparatively gradual, the rapidity of the changeover being determined by the advantages obtained and the seriousness of the need for the products obtained. And it appears reasonable to assume that much of the pressure for revamping refining processes will be that of increased yields, better economy of power and heat which may be had by using these new methods, rather than to make smaller yields of higher-quality materials. A review of probable requirements in specifications is useful in indicating what the refiner may be called on to make competitively for the postwar customer.

Qualities and specifications are subject both to actual consumer demand as dictated by technical considerations such as antiknock requirements, freedom from vapor lock, easy starting, etc., in motor fuels, and to the sales-competition pressure as exerted by sales departments on the manufacturing divisions of refining companies. In general the actual level of these specifications is the sum of the specification level demanded by automotive equipment plus the additional quality degree demanded by sales-advantage considerations. The final answer is generally that the qualities of a given product such as motor fuel are at or near the very top of the bracket which may be required by any reasonable technical consideration of the equipment supplied. Sales competition may be expected to force octane numbers higher than good engineering requirements demand. In fact, in a recent discussion a prominent engineer-executive listed three grades of postwar gasoline as to octane rating: regular, premium, and "advertised," the last being much higher in rating than the other two.[3] Other than in agreeing that a gradual upswing in octane number of motor and aviation fuel is inevitable, postwar, authorities are not in unison on many conditions to be expected in that period. Brown



We are now concluding work upon our portion of the construction program sponsored by agencies of our Government for the production of high octane aviation motor fuel, and now have available every facility necessary to the speedy, economical and workmanlike construction of petroleum processing plants or units.

MID-CONTINENT ENGINEERING CO., INC.

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and Barnard[3] say "immediately after the war we can expect that the average octane-number level of motor gasoline may increase as much as three units over immediate prewar values." House-brand fuels will be around 80 A.S.T.M., they say, with a premium-fuel rating of around 85 A.S.T.M. Russell[3] in discussing this idea states that if A.S.T.M. numbers be converted to road octane numbers we will have little spread between the 90-95 range he mentions and the 80-85 range given by Brown and Barnard, the higher numerical range being on the so-called Army method of test. Chayne says that engine designers can "get along" fairly well building for fuels of up to about 85 octane number, then run into serious limiting troubles. Rigidity of engine parts, unit bearing pressures, excessive engine noises when operating under high compression pressures necessary to obtain the full efficiency of the fuel all limit the speed with which the engine maker can design for superfuels for automotive equipment. Customer reaction to noisy, rough-running high-compression engines is unfavorable. "I think I am safe," Chayne says, "in making the statement that as of today no one knows how to make a 100-octane fuel engine that is 'sweet' enough to try to sell to a customer." Therefore customer reaction will militate against too rapid boosting of compression pressures and octane number in fuels.

Schlesman[4] opines that the car developed within the next decade will make 40 miles per gallon of fuel while cruising at 60 miles per hour on 35 hp. output, will operate nearer its maximum output at cruising speeds as some foreign engines do. He believes there exists no reason for boosting octane number above 90 (presumably A.S.T.M. Motor Method). He says our air transport fleet will number 4,000 planes immediately postwar and will use 75,000 bbl. of 100-octane number fuel per day. Significantly Schlesman remarks, "It is just as practical to design the car of tomorrow to operate at high efficiency on fuels of zero octane number."

Colwell,[5] S.A.E. past president, says that no new car models will be built for 18 months after the war's end. He believes four grades of fuel will be made postwar for the 1942 models which will be built first: aviation, 100-octane number and up; premium, 85-87-octane number; regular, 75-77, and third grade, 70. Compression ratios will go up but not above about 8:1, economical operation will govern car usage; but he does not foresee the ultra-small, Bantam-type car such as has been popular in Europe.

Chayne points out that we are approaching via the high-octane-number, increasing-compression - pressure route the limiting pressures in the explosion cylinder of the spark-ignition engine those pressures attained in the compression-ignition (diesel) engine. Under comparable pressures these two cycles will show the same efficiency in operation; these maximum pressures are about 1,200 lb. per sq. in. in each case. Taylor[3] in discussing the same subject states that one of the most practicable routes for obtaining better efficiency in engines with greatly reduced refining losses is by the diesel engine. Fuels for the diesel are producible directly from crude by simple distillation without the relatively heavy losses sustained by cracking and treating as in production of high octane-number gasolines, he shows.

Arguments For and Against Octane Number Boost

Numerous reasons are brought forward for and against increase in octane numbers in motor fuels, postwar. Some of the reasons for such increase are:

1. Competition will force increases inevitably.

2. Engine efficiency increase with boosted octane number will more than offset higher unit fuel costs.

3. Large octane-number producing capacity already operating at the war's end—catalytic cracking, alkylation, hydrogenation—will make octane number boosts easy and inexpensive.

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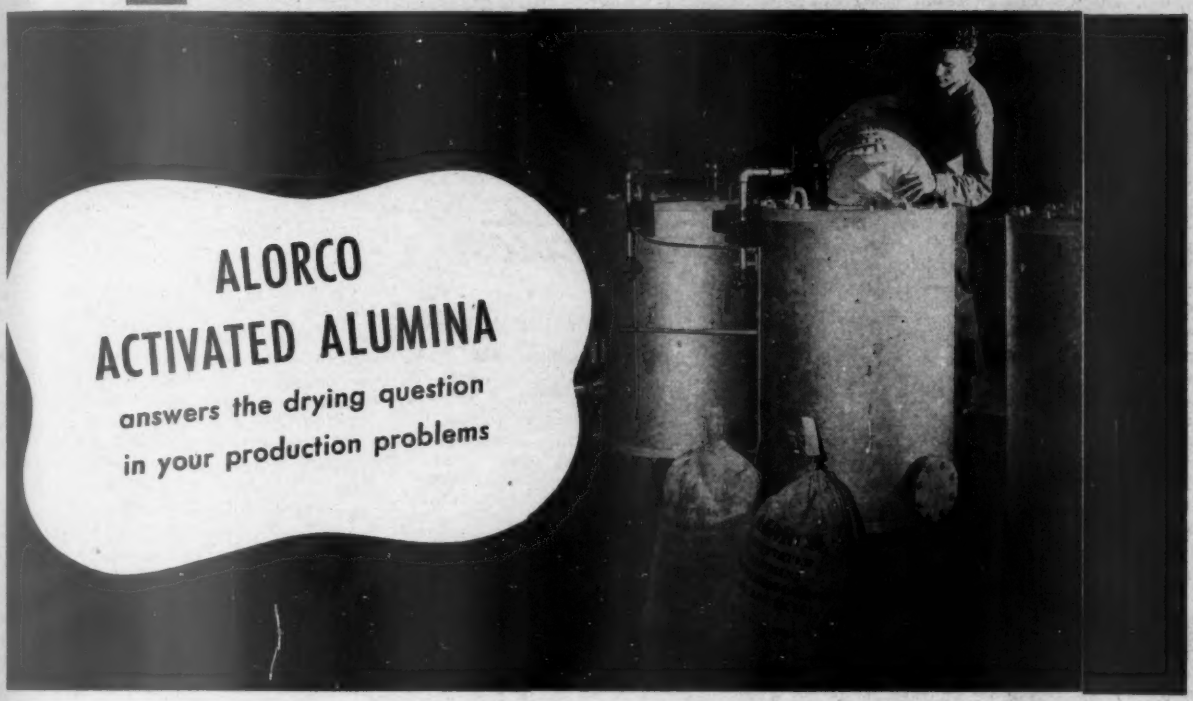

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tane-number — fuels will conserve crude by higher power output per barrel of crude used.

Arguments against octane number increases postwar are:

1. Threatened crude shortage demands highest yields, which are higher with thermal than with catalytic cracking.

2. Losses of crude in producing higher octane-number fuels are too great, too wasteful without adequate return.

3. Design of automotive equipment, engines, for ultra-high octane-number fuels offers too much difficulty with present "know-how" to make their improvement above about 87 octane number feasible or desirable by the customer.

Taylor (loc. cit.) points out that, in early refining practice, about 1 gallon of crude was consumed in the simple refinery operations per barrel of crude processed, or about 2.4 per cent of the gross charge to the stills. As of the 1940's the destruction of crude at the refinery he says is nearer 6 gallons per barrel, or about 14 per cent. (Obviously this figure is average and varies widely in different refineries.) If this figure is correct, then the processing of the 1,600,000,000 bbl. of crude during 1944 (estimated from recent weekly crude runs) will cost 220,000,000 bbl. of crude, an exorbitant figure it seems. If this consumption — cracked gas, tars, degraded fuel oil used in the refineries or sold as residual fuel — is reduced by one-half, 110,000,000 bbl. of crude may be saved, the antagonists of rapid octane-number boosts say. At a gasoline yield of 43 per cent, average, this saving will supply 50,000,000 bbl. of motor fuel, an important addition to civilian rationed gasoline supplies, the refiners assert. Further, advocates of better economy in crude utilization urge that every effort be made to increase the percentage of motor fuel from available crude by cracking for maximum yields of minimum permissible octane number fuels, supplying the additional required octane numbers by use of maximum amounts of TEL.

Catalytic Cracking Capacity, and Probable Demands

A total of 94 units operating catalytic cracking, alkylation, and allied processes are either in operation, or to be completed sometime in 1944, according to the best available information we have. Their total capacity of 100 octane-number components is not known. It is understood that these units can produce up to about 15 per cent more catalytically cracked naphtha suitable for motor fuel than they can make to meet the more restrictive aviation fuel specifications. If, for the sake of comparisons we assume—and it is purely an assumption—that these units can produce an average of 5,000 bbl. per day of motor-fuel components or that equivalent for aviation fuel, the total possible catalytically cracked naphtha now projected or expectable is somewhere around 450,000 bbl. per day.

Estimates of from 50,000 bbl. to 100,000 bbl. per day of 100 octane-number aviation fuel for purely military purposes, postwar, have been made by well-informed though hardly clairvoyant authorities. If this average amount of aviation fuel is deducted from the probable or possible total mentioned above there remains some 400,000 bbl. per day, maximum, of catalytic cracking capacity to apply to motor-fuel production. Brown and Barnard estimate that the catalytic gasoline made in these units will rate 10 to 12 octane numbers higher than the materials which that gasoline will replace; that thus an average of two to three octane numbers increase in ratings for average house-brand gasoline is made practicable. (Available data show 83-84 octane from naphthenic stocks, 80-81 for paraffinic stocks A.S.T.M.) It is to be understood that by no means will thermal cracking capacity be pushed out the window by the so far much more expensive catalytic processes except where the demand for "octanes" outweighs that of higher yields of gasoline of thermal octane rating caliber.

One consideration which may dic-

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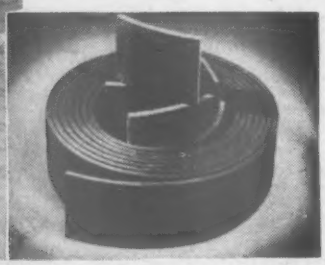

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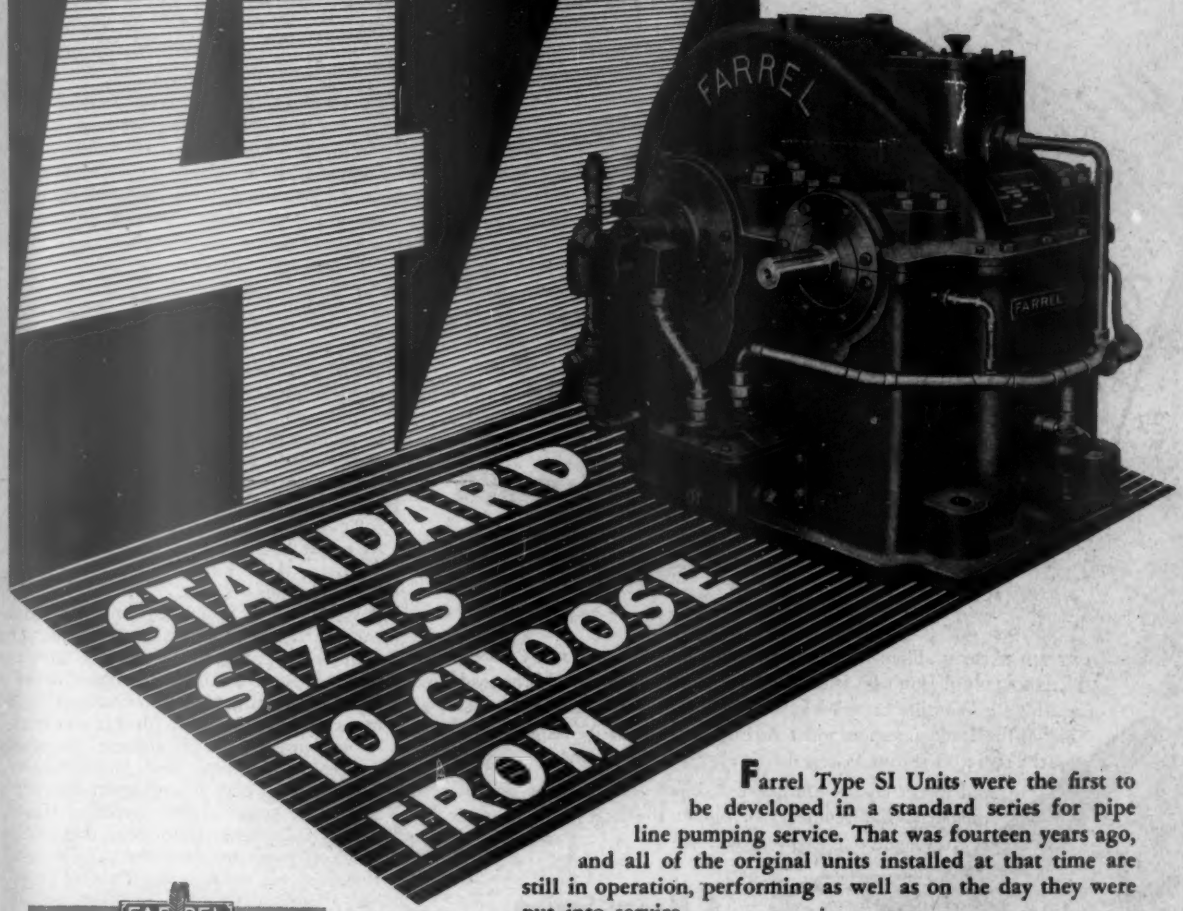

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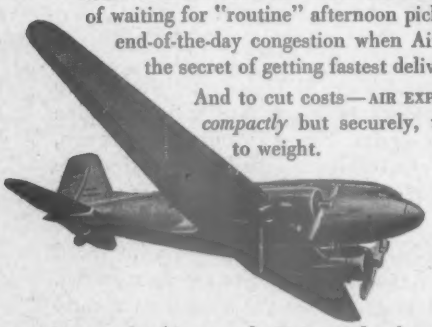

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tate building of new catalytic-cracking capacity or transfer of existing units from one locality to another is that of octane-rating competiton coupled with the fact that this cracking capacity is concentrated in a few areas, not generally distributed to serve all refiners during normal times. For example, 40 per cent of our total aviation-fuel capacity is concentrated in the Gulf Coast area. The northern Midwest area and the Middle Atlantic states area account for probably 40 per cent more, leaving only about 20 per cent or thereabouts distributed through the remainder of the country, a large portion of it on the Pacific Coast.

Thus, if we assume that our present catalytic-cracking capacity is adequate to supply the added octane numbers which competition and technical progress may require in the postwar economy, this capacity is not equitably or economically distributed geographically. Much of our inland gasoline-producing capacity is not near enough to catalytic-cracking capacity to enable refiners to blend high-octane catalytic gasoline with their own production economically, even though they may be able to buy this blending material from a competitor refiner. Therefore it may be that competition alone may force the refiner now without catalytic capacity to build such even if it provides the country with excess catalytic-cracking facilities.

With yields of 60-75 per cent from thermal cracking, and of 35-60 per cent from catalytic processes—so far as data are available now—the refiner operating thermal crackers will have plenty of outlet for his obviously cheaper 70 - 75 octane - number house-brand motor fuel. Catalytically cracked fuel offers somewhat less difficulty in some of its chemical treating requirements than does thermally cracked naphtha, thus is expected to cost less on that score. This is probably the only item of cost which is less than for catalytic than for thermal operations.

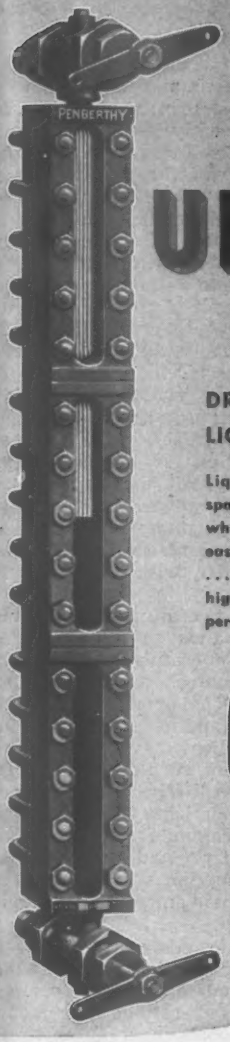
However, in yields other than gasoline the catalytic cracker has some advantages. A typical comparative yield balance* is shown as follows, operating on the same gas oil in each case:

	Catalytic cracking per cent	Thermal cracking per cent
Motor gasoline	45.0	32.0
No. 2 heating oil	40.0	25.0
Fuel oil (residual)	10.0	38.0

*Private communication.

It is understood that with these yields the catalytic cycle stock can be "reworked" to give about 80 per cent heating oil and 20 per cent distillate fuel blending stock (diesel, etc.), resulting in the over-all yields as shown.

On the basis of a charge capacity of 1,000,000 bbl. of gas oil per day in the U.S.A., the total yields from the



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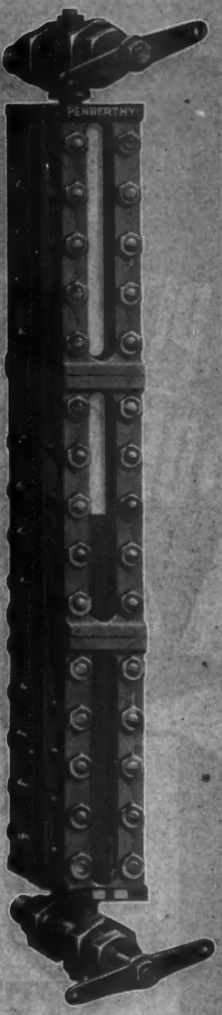

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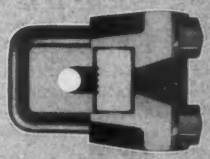

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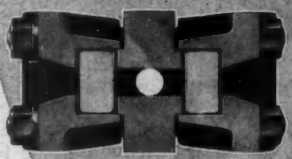

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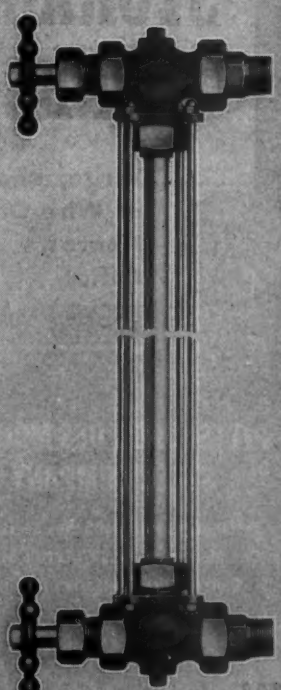

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two types of cracking processes are quoted as follows*:

	Catalytic bbl./day	Thermal bbl./day
Motor gasoline	450,000	250,000
Heating oil—		
Cycle stock	400,000	200,000
Virgin	.....	200,000
Fuel oil (residual)	100,000	300,000

Under such a yield arrangement the advantage of total sales income makes the balance importantly in favor of the catalytic operation, without considering comparative investment and operating costs.

Postwar Diesel Fuels

Considerable concern has been expressed especially by diesel-engine operators, as to what effect these new war-developed processes may have on diesel fuels. Data available* indicate that catalytic recycle gas oil varies somewhat in combustion-ignition qualities. Passage through a catalytic-cracking unit reduces the cetane number of such products by varying degrees, dependent on both the details of the process and the nature of the raw charge stock. Analogous to thermal operations, the more naphthenic types of charge stocks (gas oils) yield higher octane-number gasolines. Consequently the tendency under a more rigid economy program will be to crack, catalytically or thermally, those more naphthenic gas oils and to release the paraffinic materials for other purposes such as diesel fuels for locomotive, automotive and similar uses. The approximate cetane numbers of different recycle stocks from catalytic processes charging different types of gas oil are shown below:

	E. Texas wide cut	W. Texas wide cut	W. Texas heavy	Coastal-wide cut
Gravity, °A.P.I.	30.0	21.7	2.27	22.0
A.S.T.M. dist. end point °F.	572	605	605	563
Aniline point, °F	144	129	124	96
Cetane number (est.)	47	24	37	30

Changing Trends in Equipment

Equipmentwise, the changes which may be expected, dealing with catalytic processes, are in the direction of cheaper alloys and lighter weights on a piece-for-piece basis. In heaters and heater coils for catalytic-cracking units plain carbon steel may be used instead of 2 per cent chrome and a larger percentage of silicon, as is used now in installations processing relatively noncorrosive crudes, or instead of 4-6 chrome-½ molybdenum as is used in very severe operations on nearly sweet crude, or even in place of 18-8 chrome-nickel or stainless (11-13 per cent Cr) steel tubes and return bends. These alloys cost from 2½ to some 10 times as much as plain carbon steel. With the simplest generally used alloy therefore, the heater coil cost is reduced by 50 per cent. Since these coils represent about one-third of the total heater cost, the total cost may be reduced as much as one-sixth, or, say, 15 per cent. Some estimates state that as much as 30 per cent saving may be effected in catalytic-cracking units for the same type and sizes of equipment, because of the milder operating conditions. This situation changes when we consider the huge cubical capacity of much of the equipment now used for catalytic units, and it appears safer to estimate that overall costs per unit of product capacity may be increased by as much as 20 to 60 per cent.

Charge and auxiliary pumps for cracking or alkylation units will doubtless increase as to effective throughput capacity, but will be lighter, cheaper. A charge pump for a catalyst unit may operate at 40-50 lb. discharge pressure whereas a hot-oil charge pump for a thermal cracker may operate at 1,200 lb. discharge or higher, with oil at 750° F. or even higher.

Increase in operating costs and in exacting demands of the catalytic cracker is in operating and in product quality control, and in catalyst regeneration. The operation of automatic valves and such controls introduces complicated systems of automatic equipment, such as the involved system used with the Houdry process for systematizing flow through the reaction chambers. Operation of large "butterfly" and gate valves, has forced adoption of more powerful units for their automatic functioning.[7]

In summation, postwar refining—

Will utilize catalytic cracking to the extent required mainly by competition in octane ratings for motor fuels, will probably supply most or all base stocks for aviation fuels;

Will boost octane numbers slowly and gradually, with no abrupt jumps because of the slowness of advances in engine design and the stern rule of economics during the reconstruction period;

Will require lighter equipment per unit, cheaper alloy metals for catalysis than for thermal cracking, with probably higher alloys to offset erosion or corrosion;

Will utilize, along with the automotive and transportation industries, the diesel engine for better economy in operation.

*Private communication.

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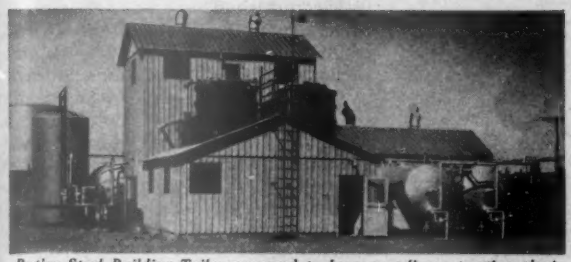
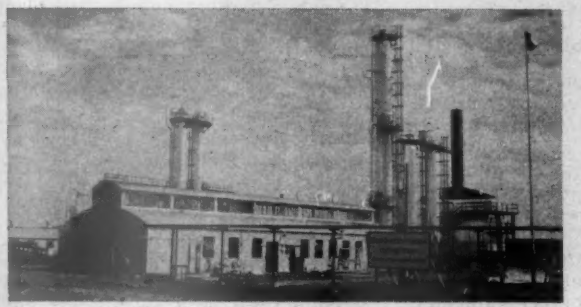
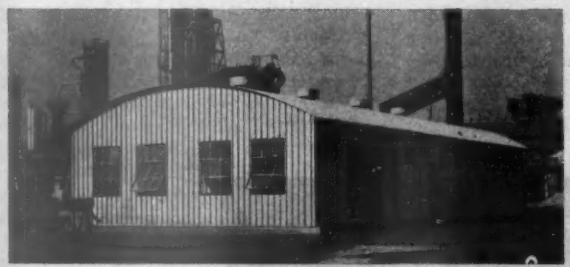
BUTLER BUILT
STEEL BUILDINGS



Butler Steel Building Tailor-measured to house a refinery treating plant.



Butler Steel Building Tailor-measured to house a modern refinery hot pump room, a cold pump room and control room.



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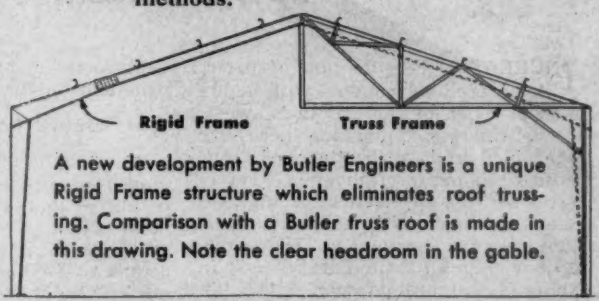
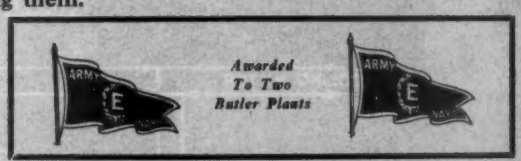


A new development by Butler Engineers is a unique Rigid Frame structure which eliminates roof trussing. Comparison with a Butler truss roof is made in this drawing. Note the clear headroom in the gable.

Many new developments are daily being proven in the strenuous tests of war. For instance, an entirely new type, hinged-arch steel building frame has been perfected. It is so simple that its parts bundle together so compactly that transport planes fly them to the battle front. Then in a matter of hours inexperienced soldiers erect a 130 ft. by 160 ft. combat hangar for fighting planes.

You will find many new advantages in postwar Butler Steel Buildings. Information on some of these can be released now for engineering study. In the meantime, it may be possible that we can fill your current requirements. Write us fully regarding them.



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Liquid Hydrocarbon Treating With Aqueous Amine Solutions

by J. D. Gordon*

INCREASED consumption of petroleum products coupled with depletion of much of the country's sweet-crude reserves is making necessary the increased utilization of sour crudes. In many of the newer processes for the production of high-octane gasoline, light liquid hydrocarbon feeds are employed. These two facts combine to stimulate interest in the removal of hydrogen sulfide in the liquid phase.

It is generally recognized that hydrogen sulfide must be removed from alkylation and polymerization feeds to prevent decreased catalyst life, reduce corrosion of refinery equipment, and to eliminate the necessity of costly after-treatments which sometimes are the cause of impaired product quality. Hydrogen-sulfide removal, in the liquid phase, also is often advantageous in the preparation of propane and butane cuts for sale as fuel.

*The Girdler Corp.

Mutual Solubilities Low

Where hydrogen sulfide may be removed at suitable pressures and temperatures in the gas phase, the Girbotol process, employing solutions of ethanolamines, has been widely accepted as a most efficient and economical method. Several years ago increasing interest in liquid phase treatment logically led to an investigation of the possibility of employing the principle of this process for liquid treatment. Experimental work proved that some of the amines are only slightly soluble in petroleum hydrocarbons. Further, the fact that hydrocarbons have a negligible solubility in aqueous amine solutions was established. Both of these important experimental conclusions have been borne out in commercial plant operation. Where the presence of a small amount of amine in the hydrocarbon has presented a problem, this has been solved by incorporating facilities for water washing the hydrocarbon after amine treatment. Where a caustic wash for the removal of mercaptans normally follows the amine treatment, the same purpose is accomplished.

Determination of distribution ratios of hydrogen sulfide between hydrocarbons and amine solutions followed by semiplant operations proved that the principles of the Girbotol process, formerly employed only for gas purification, were equally efficient and economical for the purification of liquids. Several commercial plant operations have also confirmed this conclusion.

Fig. 1 is a simplified flow diagram of a liquid hydrocarbon treating plant. The process flow and equipment are similar in gas and liquid treating except that in liquid treating facilities are added to provide settling time for the separation of any entrained amine solution from the purified hydrocarbon and for the separation of any entrained hydrocarbon from the rich amine solution.

Combination With Caustic Wash

Towers packed with stoneware Raschig rings have been found most suitable for contacting solution and hydrocarbon. The solution is maintained as the continuous phase in the contactor.

In most installations heat for regeneration of the solution is provided by a closed reboiler in or adjacent to the base of the reactivator, with steam or hot oil as the heating medium. A recent improvement has been patented, however, for use in those installations where hydrogen sulfide removal is followed by a similar regenerative cycle for mercaptan removal employing caustic soda or the equivalent as the absorbent for the mercaptans. In such a combination plant, the overhead steam from the mercaptan plant reactivator may be used as direct stripping steam in the Girbotol reactivator, thus reducing the quantity of steam and cooling water required for the combination plant.

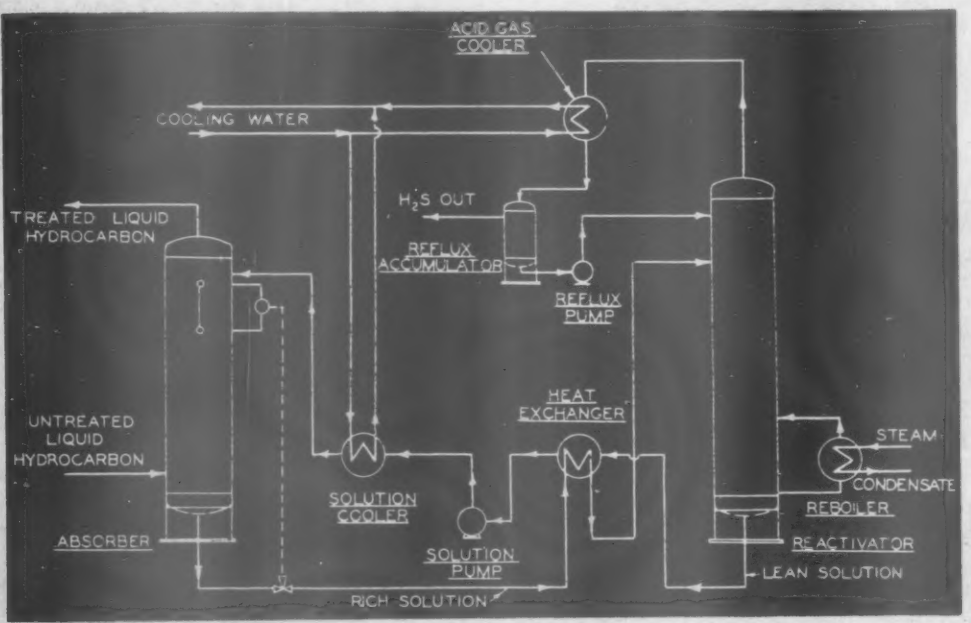

Fig. 1: Simplified flow diagram of liquid hydrocarbon treating process using aqueous amine solutions

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Reforming and Polymerization Are Major Tools for Postwar Refining

by R. P. Mase and M. C. Turner**

Refiners who have no catalytic-cracking equipment can yet do several things to improve their own operations, some of which must wait the winning of the war and the availability of equipment: (1) Fractionate out propane and replace it with butanes, in motor fuels. (2) Reform either the whole straightrun gasoline fraction or a selected low-octane heavy naphtha; polymerize the light olefinic gases so formed to return most of the loss to motor fuel to improve octane number and yield. (3) Use better fractionation. (4) Desulfurize to make higher octane number with the same amount of TEL, or the same octane number with smaller amounts of TEL. Other suggestions are included in this practical presentation of what the refiner can do to improve his interwar and postwar operations.

Polymerization is a two-edged tool for the refiner without catalytic-cracking capacity; he improves octane number and increases gasoline yield, offsetting most of the reforming and cracking volume losses

BEFORE we can seriously consider refinery equipment and operations for postwar motor-fuel manufacture, we must form as definite opinions as possible concerning quantities and specifications of motor fuels that will be required. We, along with many others, believe the postwar motor-fuel demand will start at a point only slightly below prewar demand. The buildup from this point depends much on economic conditions. We would not care to predict beyond the statement that there will be a year-to-year increase similar to prewar increases, the rate depending on economic conditions at the time.

Since refining capacity has been increased during the war while motor-fuel market demand is expected to start at a little less than the level prior to the war, it is apparent that not all refiners will be able to market their total possible production of motor fuels. It is advisable that refiners who want to keep apace, do what they can at the earliest possible time to meet motor-fuel market demands that will prevail during the postwar period.

*Engineering and construction division, Jones & Laughlin Supply Co.

Postwar specifications, particularly octane requirements, are a matter of conjecture, but there are certain indications and trends apparent that can be used to predict broadly future motor-fuel specifications.

It can be said safely that third-grade motor fuel will face a declining market. Premium grades will doubtlessly be in demand and will enjoy a considerable but limited use because of price differential. House-brand or middle-grade gasoline will enjoy the broadest demand, as it has in the past. It is particularly the octane number of middle-grade or house-brand gasoline that we are considering in the following discussion.

Facts Affecting Octane Number

Facts principally affecting octane number of house-brand gasoline may be set forth briefly as follows: Those tending toward increased octane number will be mentioned first.

(a) Many refineries at the close of the war will be equipped with catalytic-cracking units, alkylation plants and the like. They will make the most capital possible out of their favorable situation by marketing and highly advertising high-octane house-brand gasoline.

(b) Automotive design will trend toward smaller, higher-compression motors in order to effect greater economy of fuel consumption.

In relation to this latter statement, there is an economic balance to take into account. Higher-octane motor fuels will cost more per gallon for reasons that are obvious. The use of higher-octane fuel will increase motor-car-engine efficiency but not necessarily in direct ratio to, or, in excess of direct ratio to the increased cost of these higher-octane motor fuels. Some value not yet established will mark the point where increasing cost per gallon will cross the line of increasing efficiency.

Reasons which tend to hold back too rapid increase of octane number are as follows:

(a) There are at present between 27 and 28 million passenger cars, trucks and buses in operation, nearly all of which were manufactured during the prewar period, and which were designed to burn 70 or lower

octane gasoline. These cars cannot benefit appreciably from the use of higher-octane gasoline. Its use would be to their disadvantage since the cost would be higher and no corresponding benefit would accrue.

(b) We are told by leaders of the automotive industry that automotive design immediately after the war will not be appreciably different from that immediately preceding the war. However, it is reasonable to assume that normal development of higher-compression, more-efficient engines will be rather rapid since this development has been given a tremendous impetus by wartime airplane development. Even so, it is impossible to replace more than 20 or 25 per cent of existing cars, trucks, and buses in any one year. The demand for higher-octane gasoline for the new cars will be tempered by the still existing demand for prewar gasoline for prewar cars.

With this in mind, it is well to take a look at the required equipment for postwar refining. Nothing herein is to be construed as a statement that catalytic cracking, for instance, will not be used in the postwar period. We believe it will be and prominently so. What we are pointing out is that many other improvements of lesser cost and magnitude can be made to keep the average refiner reasonably in step with immediate postwar octane requirements. Some of these are simple things that should have been done long ago. Typical improvements are mentioned as follows in the full knowledge that many refiners have already made these improvements.

(a) Some refiners are operating without adequate stabilizing equipment for their motor fuels with the result that from a fractional percentage up to 2 per cent of propane is present in their gasolines. If stabilizing equipment were installed to remove this propane and substitute for it, an average mixture of iso and normal butanes, an octane increase of approximately 0.6 point could be anticipated for each per cent of propane that is replaced by mixed butanes. A volume increase of motor fuel of approximately 2½ per cent would also result from each volume of propane that is displaced by butanes.

(b) Many refiners have inadequate or obsolete type vapor-recovery equipment. Butanes are lost to fuel which should be used in motor fuels either instead of propane, as per preceding paragraph, or instead of purchased casinghead gasoline. In extreme cases, pentane and heavier hydrocarbons are being lost with treated gas from vapor-recovery equipment. Such losses not only reduce the total volume of motor fuel from a given amount of crude, but reduce octane number of resulting motor fuel because isopentane in particular is one of the best antiknock hydrocarbons. For each per cent of gasoline (as pentane and heavier) that is lost through inefficient vapor-recovery equipment, a loss of approximately 0.2 point of octane number is probable.

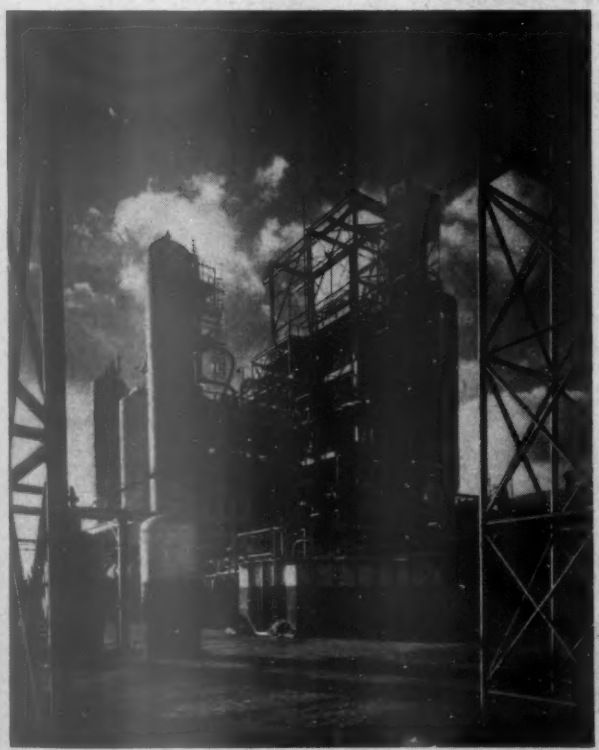
(c) Many refineries do not have adequate reforming facilities. Reforming is in bad stead in many quarters because losses from the operation are considered excessive. These losses can be materially reduced by installation of nonselective polymerization equipment.

(d) Polymerization units should be considered if not already installed. There is also a place for alkylation, but we do not believe it will displace polymerization for motor-fuel production. Alkylation is ideal for high-octane aviation-gasoline production, but for motor-fuel manufacture nonselective polymerization will be found economically advantageous.

By the use of polymerization, a considerable part of the losses encountered in reforming can be recovered and returned as 80-octane gasoline for blending with motor fuels.

By the combined reforming and polymerization setup, either the heaviest third of straightrun gasoline in the form of naphtha, or alternately, the whole straightrun gasoline can be reformed and brought into an octane bracket sufficiently high so that it can probably be used in its entirety in postwar motor fuels.

(e) Thermal-cracking operations can well be studied and improved in or-



Left: The polyforming process operates on vapors and liquids produced in the conventional refinery and can do much to improve motor-fuel output. Right: Fractionation and the segregation of crude components as desired will do a great deal to improve maximum yields of the most expensive products in the postwar refinery

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der to increase octane number of cracked motor fuels. As a starting point in this, we suggest the following:

1. Furnace feed stocks should be reasonably sharply fractionated into two or three cuts so that optimum temperature, pressure, and time can be applied to each cut in its respective coil.

2. As severe cracking conditions as reasonably possible should be applied to all cuts. Gas-measurement means should be used as spot indication of severity of cracking.

3. A longer period systematic check should be worked out and applied to show economic value of increased clear octane and lead susceptibility against increasing "gas and loss." This of course becomes a serious problem when charging stocks are changed frequently.

(f) Sulfur-removel systems for motor-fuel treating should be considered. Plumbite and similar treating systems have been useful in meeting technical specifications for sweet gasoline, but they do not remove or destroy the sulfur compounds that lower lead susceptibility. Several sulfur or mercaptan removal processes are available which remove all or certain sulfur compounds so that higher octane can be produced with the same amount of lead, or conversely, the same octane gasoline can be produced with less lead. There is available to the industry at the present time a considerable volume of data covering the effects of the several sulfur compounds that occur in motor fuels, on clear octane and leaded octane numbers of straightrun, cracked, polymer, natural, and aviation gasolines. The total sulfur content, but more the particular sulfur compounds that are present affect the lead susceptibility. Each gasoline under consideration should be given a laboratory investigation before conclusions concerning sulfur removal are reached. In general, we may say that straightrun motor fuels from medium and sour crudes show a clear octane improvement from catalytic desulfurization of from 1 to 2 points. With 3 cc. of lead, the octane improvement is commonly from 5 to 8 points greater than when leaded before desulfurization.

Thermally cracked gasoline from medium or sour crudes commonly show clear octane improvement of from 0 to 1 points on mercaptan removal. With 3 cc. of lead the improvement ranges from 2 to 5 points higher than when leaded before mercaptan removal. Polymer gasolines react somewhat similar to thermally cracked gasolines while absorption gasolines show results rather similar to straightrun. Aviation blends show octane improvement within the above ranges, depending on sulfur content and combustion of the several components.

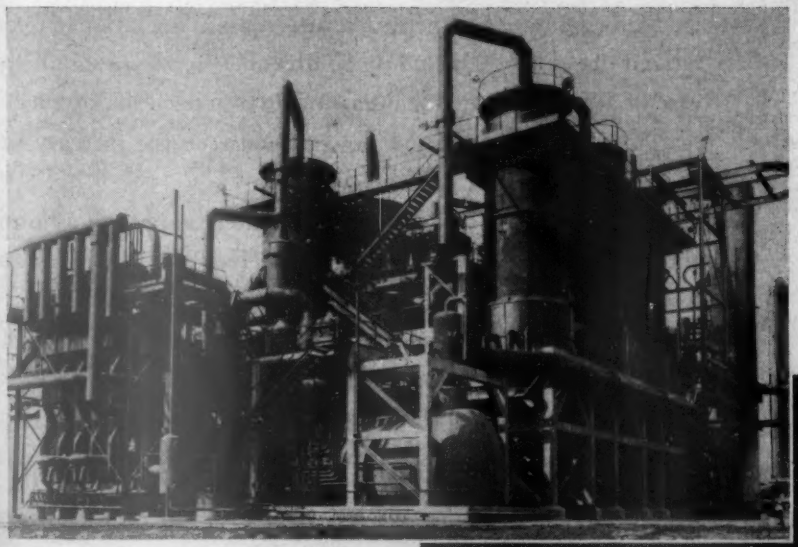
Properties of Typical Products Refined By Houdry Cracking Process

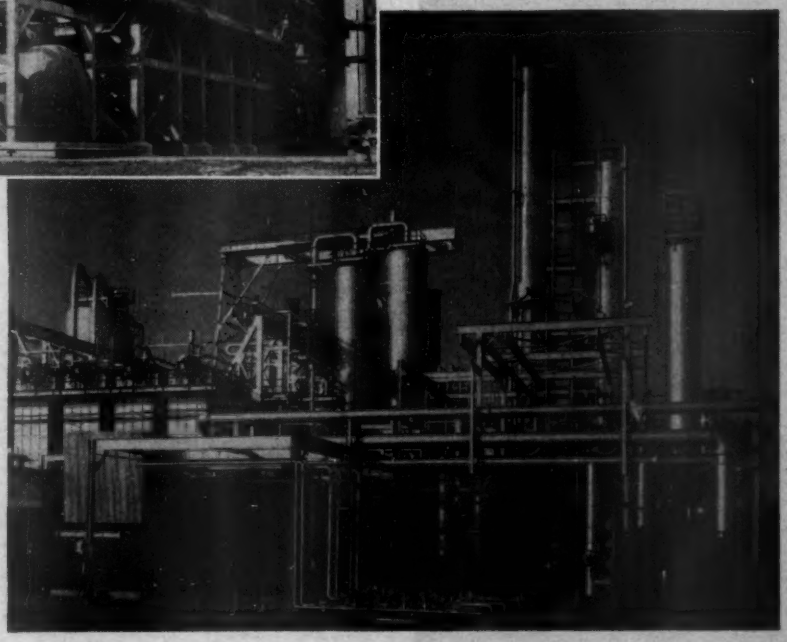
by E. A. Smith and R. E. Bland**

THE attached tables present inspection data on typical products prepared by the Houdry (fixed-bed catalytic) cracking process (employing an extraneous heat-exchange medium) when charging a variety of charging stocks covering the naphthenic, mixed base, and paraffinic types.

Table 1—Typical motor gasolines.
Table 2—Typical aviation gasolines.
Table 3—Typical catalytic gas oils and furnace oil cuts.
Table 4—Effect of cracking severity on diesel index of catalytic gas oils.

Refiners need a great amount of data regarding the properties and characteristics of products from catalytic cracking and other ultra-new processes, in order to understand better what may be done with these processes postwar. This article gives careful details of the properties of gasoline, recycle stock and furnace and diesel fuels as prepared from various stocks in Houdry cracking units.





Left: Standard Oil Co. of California's Houdry catalytic-cracking plant which began turning out 100-octane aviation gasoline in September 1942. At the left in the picture is the waste-heat recovery steam boiler with the salt-storage drum in the center foreground and the catalyst cases in the background to right. Below: Socony-Vacuum Oil Co., Inc.'s, Houdry catalytic unit at Trenton, Mich.

Generally speaking, naphthenic-type oils are superior catalytic charge stocks for producing aviation and motor gasolines, whereas the paraffinic oils yield better grades of catalytic diesel fuels if judged by their cetane numbers. Actually, it is possible to control the yields and quality of products from any given charge stock over wide limits by adjusting the operating conditions. This flexibility, inherent in catalytic cracking, makes it extremely attractive to the refiner because it offers a process by which he can control the quality of products and their yields so that changing market demands can be met readily whether it be for motor gasoline, aviation gasoline, diesel fuels, fuel oils, light products, etc. It also provides a means for compensating for differences in charging stocks.

*Catalytic Development Corp.

Typical Motor Gasolines

Shown in Table 1 are inspections of catalytic motor gasolines produced from light and heavy gas oils ranging in type from the highly naphthenic Mirando gas oil ("K" value = 11.05, aniline point 126° F.) to the paraffinic Oklahoma City gas oil (K, 11.95; aniline point, 172° F.), and Mid-Continent gas oil (K, 11.9; aniline point, 179° F.). It will be seen that the C.F.R. motor method octanes on gasolines from light gas oils vary between 77-80 clear, and between 88-89 with 3 cc. TEL. Usually the octane numbers are about one unit higher from heavier

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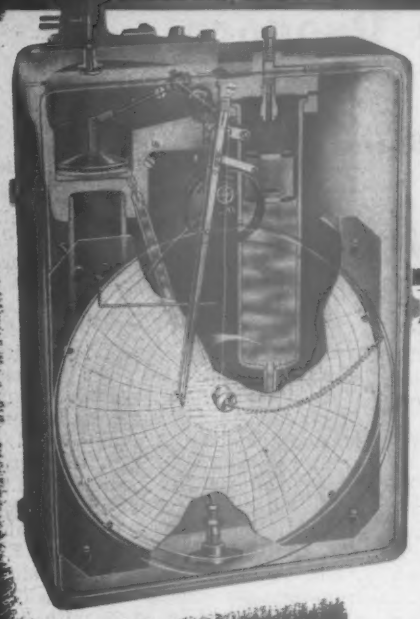

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TABLE 1—TYPICAL HOUDRY CRACKED MOTOR GASOLINES FROM VARIOUS CHARGING STOCKS

Type operation	Cracking—Single pass															
Crude source boiling range cat. chg.	East Texas light gas oil		East Texas heavy gas oil		Grade B. coastal 42.6 per cent crude light gas oil		Okla. City crude 29.0-57.6% crude light gas oil		Mid-Continent 37.8° A.P.I. light gas oil		Mid-Continent 30.7° A.P.I. heavy gas oil		Mirando crude 24.3° A.P.I. gas oil	
	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline	Fresh cat. charge	Untreated cracked gasoline
Gravity, °A.P.I.	36.3	63.4	29.1	54.8	30.9	*60.4	37.1	61.0	37.8	62.3	30.7	...	24.3	52.8
I.B.P.	440	78	...	80	424	95	423	92	416	80	440	Stab.	408	102
10	484	116	...	123	486	132	473	121	498	134	528	motor	464	133
30	510	167	(†)	179	520	187	509	169	522	172	592	gasoline	513	203
50	534	232	...	234	550	238	543	237	536	227	665	10-lb. R.V.P.	552	273
90	640	384	...	373	680	350	638	365	586	346	888	410° F.	729	368
End point	724	405	...	398	734	413	688	405	656	385	900	end point	758	395
Sulfur	0.18	...	...	...	0.16	0.01	...	...	0.22	0.01	0.41	0.03	...	...
Aniline point	165	...	...	...	151	...	172	104	179	...	180	...	126	80
Watson & Nelson "K"	11.8	...	...	...	11.56	...	11.95	...	11.9	...	11.9	...	11.05	...
R.V.P.	...	12.6	...	9.2	...	...	...	9.3	...	11.6	...	10	...	9.6
Octanes:														
C.F.R.-M clear	...	79.9	...	79.1	...	80.5	...	77.4	...	78.2	...	79.1	...	80.9
+1 cc. TEL	...	85.7	...	82.3	...	...	...	84.4	...	...	...	82.3	...	85.0
+3 cc. TEL	...	89.4	...	85.4	...	90.2	...	87.5	...	88.6	...	85.6	...	88.0
C.F.R.-R clear	...	...	...	...	...	...	...	83.9	...	...	...	89.7	...	91.8
+1 cc. TEL	...	...	...	...	...	...	...	91.1	...	...	...	93.2	...	95.9
+3 cc. TEL	...	...	...	...	...	...	...	94.4	...	...	...	96.7	...	97.8
Color	...	...	...	...	...	30	...	19	...	30	...	...	...	15
Gum, A.S.T.M.	...	...	...	...	...	1	...	1	...	0	...	...	...	
Cu dish	...	...	...	...	...	3	...	8	...	1	...	...	...	7
Ox bomb Ind. hrs.	...	...	...	...	...	10+	...	10+	...	...	...	...	...	7+

*Stab. gravity. †440-950° F. boiling range.

gas oils, but the lead susceptibilities are slightly less giving 85-86 with 3 cc. TEL.

The C.F.R. research octanes fall within the range 84-92 (without lead) and 94-98 (+3 cc. TEL) depending on the type and boiling range of the charge.

All of these motor gasolines are untreated single-pass products. Gasolines from cracking light gas oils are of satisfactory quality without any further treatment. Gasolines from the very heavy gas oils and from high-sulfur charge stocks may require a treating operation to sweeten and stabilize the quality.

Typical Aviation Gasolines

Shown in Table 2 are typical Houdry aviation-base gasolines prepared from heavy naphthas, light gas oils and heavy gas oils. Usually, it is the preferred practice to catalytically retreat for the maximum quality, however, as noted in the table, aviation-base gasolines can be obtained directly by cracking of naphthenic heavy naphthas, product having 98 AFD-1C octane number (+4 cc. TEL) and 96 octane number from the moderately paraffinic East Texas heavy naphtha. After treating, the two base gasolines show about the same quality, 99 1C octane number.

It can be seen that retreated aviation-base gasolines from light and heavy gas oils from the two types of charge stocks have AFD-1C octanes in the range 98-99 with 4 cc. TEL at 7 lb. R.V.P. After retreating, all of the base gasolines have high quality in so far as color, gums, stability, etc., are concerned.

These examples were selected as typical base gasolines and do not necessarily represent the ultimate or even the optimum results that might apply to a given situation.

Typical Catalytic Gas Oils and Furnace Oil Cuts

Summarized in Table 3 are several examples of catalytic recycle stocks and furnace oil cuts obtained from a variety of catalytic charge stocks. Table 4 shows the effect of cracking severity on the yield and cetane number of the full catalytic recycle stock.

It is well known that diesel fuels having the highest cetane numbers are obtained by using virgin paraffinic stocks. Cracked gas oils have lower cetane numbers because of the change in chemical composition effected by cracking. On the other hand,

TABLE 2—TYPICAL AVIATION-BASE GASOLINES PREPARED BY THE HOUDRY CATALYTIC-CRACKING PROCESS

Type operation	Cracking and treating											
Crude source boiling range catalytic charge	Hvy. Gr. B coast. heavy naphtha		Hvy. Gr. B coast. Light gas oil		Grade B coastal heavy gas oil		East Texas heavy naphtha		East Texas light gas oil		East Texas heavy gas oil	
	Charge	Product	Charge	Product	Charge	Product	Charge	Product	Charge	Product	Charge	Product
Gravity, °A.P.I.	39.7	55.1	29.8	58.1	28.8 (vac.)	58.9	42.7	59.2	35.7	(65.6)	31.0	57.3
I.B.P.	359	108	374	112	365	116	...	116	432	102	460	110
10	374	148	500	132	520	136	...	140	480	120	520	140
30	386	176	527	160	592	158	...	162	512	137	593	164
50	396	210	547	200	654	196	...	198	538	168	682	210
90	433	294	628	298	859	293	...	294	640	277	906	304
End point	459	328	664	330	943	324	...	342	724	319	970	340
Sulfur	...	...	...	...	...	...	...	...	0.13	0.02	...	...
Aniline point	129	...	151	...	171	...	138	...	...	...	184	...
Watson & Nelson K	11.5	...	11.4	...	11.73	...	11.7	...	...	...	12.0	...
Acid heat	...	18	...	8	...	12	...	19	...	7	...	10
R.V.P.	...	7.0	...	7.0	...	7.0	...	7.0	...	7.0	...	...
AFD-1C + 4 cc. TEL	...	98.1	...	98.3	...	98.5	...	96.1	...	99.0	...	98.0

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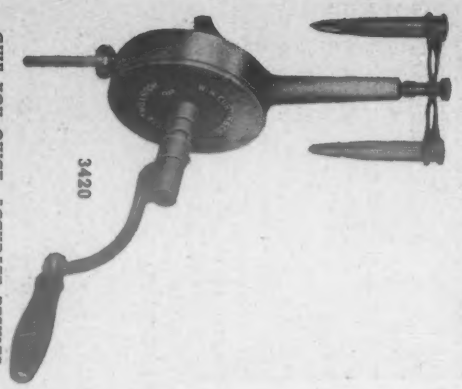

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TABLE 3—TYPICAL CATALYTIC GAS OILS AND FURNACE OILS PREPARED BY THE HOUDRY CRACKING PROCESS

Crude source	Mount Pleasant		East Texas		Lafitte		Lafitte		West Texas		Mid-Continent				Heavy Gr. B coastal		Hvy. Gr. B coastal	
Frac. of crude chg. to cat.	50 1-91.7% crude		42-88% cut		35.1-93.3%		35-65%		33.8-65%						39.8% vol. of crude		27-83% of crude	
Boil. range G.O. chg to cat.	Heavy gas oil		Heavy gas oil		Heavy gas oil		Light gas oil		light gas oil		Light gas oil				light gas oil		heavy gas oil	
Catalytic operation	1 pass		1 pass		1 pass		1 pass		1 pass		1 pass	4 passes			1 pass		1 pass	
	Fresh charge	Furnace oil cut	Fresh charge	Furnace oil cut	Fresh charge	Furnace oil cut	Fresh charge	Furnace oil cut	Fresh charge	Furnace oil cut	Fresh charge	Full cat. recycle*	Full cat. recycle	Furnace oil cut	Fresh charge	Full recycle	Fresh charge	
Gravity, °A.P.I.	30.2	32.0	29.3	32.0	31.8	33.3	36.9	34.5	30.4	31.9	37.8	35.1	30.8	33.2	31.3	25.6	28.8	24.1
Type distillation	ASTM	ASTM	Vacuum	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	ASTM	Vacuum	ASTM
I.B.P.	530	460	317	433	496	440	444	437	440	406	416	432	427	425	484	...	365	464
5	560	484	507	448	524	463	494	463	478	422	454	452	461	460	518		469	484
10	571	496	523	455	542	476	506	472	492	428	496	478	473	467	529	480	520	502
20	598	510	560	464	571	489	526	486	510	435	513	488	480	479	542		563	512
50	708	544	655	489	660	526	562	526	554	456	536	518	503	498	576	528	654	556
70		570	723	508	736	557	588	554	592	473	552	536	522	512	620		743	598
90		606	891	546	...	603	624	601	644	502	586	572	562	539	680	624	859	678
End point		654	915	602	...	655	660	672	683	560	656	672	691	592	716	724	943	706
Color, N.P.A.		1½	...	...	...	1½+		...	1½+	1½+	2½	...	...	...	...	...	...	...
Sulfur		0.12	0.35	0.04	0.21	0.08	0.12	0.07	0.81	0.3	0.22	0.04	0.09		0.21	0.12	0.16	
Con. Car.		...	0.49	...	0.36	0.01		0.05	...	...	...	0.04	0.09	0.08				
F.P.M.		225	...	...	275	212	134	212	210	186	206	206	188	155				
S.U. Vis. at 100° F.	90	37	32 to 130	30	110	37	41	36	41	33	68	35	35	34	150	111	171	124
Pour, °F.		+15	+90	—10		+15	+20	+10	—50	—(—60)	+55	+15	+20	+20				
Aniline point, °F.		141	188	114	191.1	142	173.5	149	141	101	179	147	125	132				
Diesel index		45.1	55.1	36.5	60.0	47.4	64	51.4	42.9	32.2	67.8	51.6	38.5	43.9	47	28.4	49.2	29.9
Cetane No.		52.2	59.0	46.0	63	54.0	65.5	57.3	50	43	69	56.5	47	51.0	53	40.7	55	41.5
Watson & Nelson "K"	12.05	11.6	11.75	11.4	12.0	11.6	12.0	11.7	11.5	11.25	11.95	11.7	11.4	11.5	11.65	11.05	11.75	11.05

TABLE 4—EFFECT OF CRACKING SEVERITY ON DIESEL INDEX OF CATALYTIC GAS OIL

	Fresh gas oil charge to catalytic process	Recycle catalytic gas oils—cracking severity varied			
		←Increasing severity			
Catalytic recycle gas oil—% Vol. Chg.		30	40.5	46.2	59.8
Gravity, °A.P.I.	35.8	29.8	31.5	32.8	33.7
I.B.P.	432	440	460	446	434
5	476	468	484	470	472
10	486	476	488	476	480
20	502	486	496	484	490
30	515	496	504	496	500
40	528	506	512	506	508
50	541	516	524	518	520
60	562	530	538	532	538
70	583	547	554	552	552
80	612	574	578	582	580
90	651	622	620	624	622
95	681	660	670	668	652
End point	722	710	722	692	686
Aniline No.	164.5	130	139.6	140	149
Diesel index	59	38.8	44	46	50.3
Cetane No.	61.5	47.5	51	52.5	55.5
Watson & Nelson "K"	11.8	11.3	11.45	11.55	11.6

Note—Above gas oils are the total recycle gas oils without fractionation for diesel boiling range.

the increase in gravity resulting from cracking may be expected to yield fuels of higher B.t.u. output per pound of fuel. Naturally, then, the degree of cracking has a decided influence on both the cetane number and gravity of the fuel; this effect is illustrated in Table 4.

The examples given in Table 3 show that it is possible to obtain cracked diesel fuels having cetane numbers above 50 from the highly paraffinic stocks such as Mount Pleasant, Lafitte and Mid-Continent. Some of the virgin naphthenic stocks will themselves have cetane numbers lower than 50, therefore, the cracked fuels will also be lower. An example of this is the West Texas stock shown in Table 3.

As previously stated, it is possible to vary the ratio of gasoline to fuel yield over a wide range by control of the operating conditions. As the yield of gasoline from a stock is increased, the yield and cetane number of the cracked fuel decreases. Conversely, if market conditions change to require more diesel fuel output and less gasoline, this can be achieved by reducing the cracking severity which increases the fuel yield, and at the same time increases its cetane number.

Kerosene

In our opinion it is better to produce illumination kerosene directly from the crude because it requires less treating to obtain a clean burning product. No data are available on production of power kerosene from catalytic cracking; however, there is little doubt that such material would be of high quality in view of the chemical composition of catalytically cracked gasolines and naphtha cuts.

Refinery Workers Study 100-Octane Operations

OIL CITY, Pa.—Preliminary to the opening of Pennzoil Co.'s new 100-octane gasoline plant at McClintock, 22 employes left recently for El Dorado, Ark., for a week's intensive study, as guests of Root Petroleum Co., of refinery technique in the manufacture of aviation gasoline.

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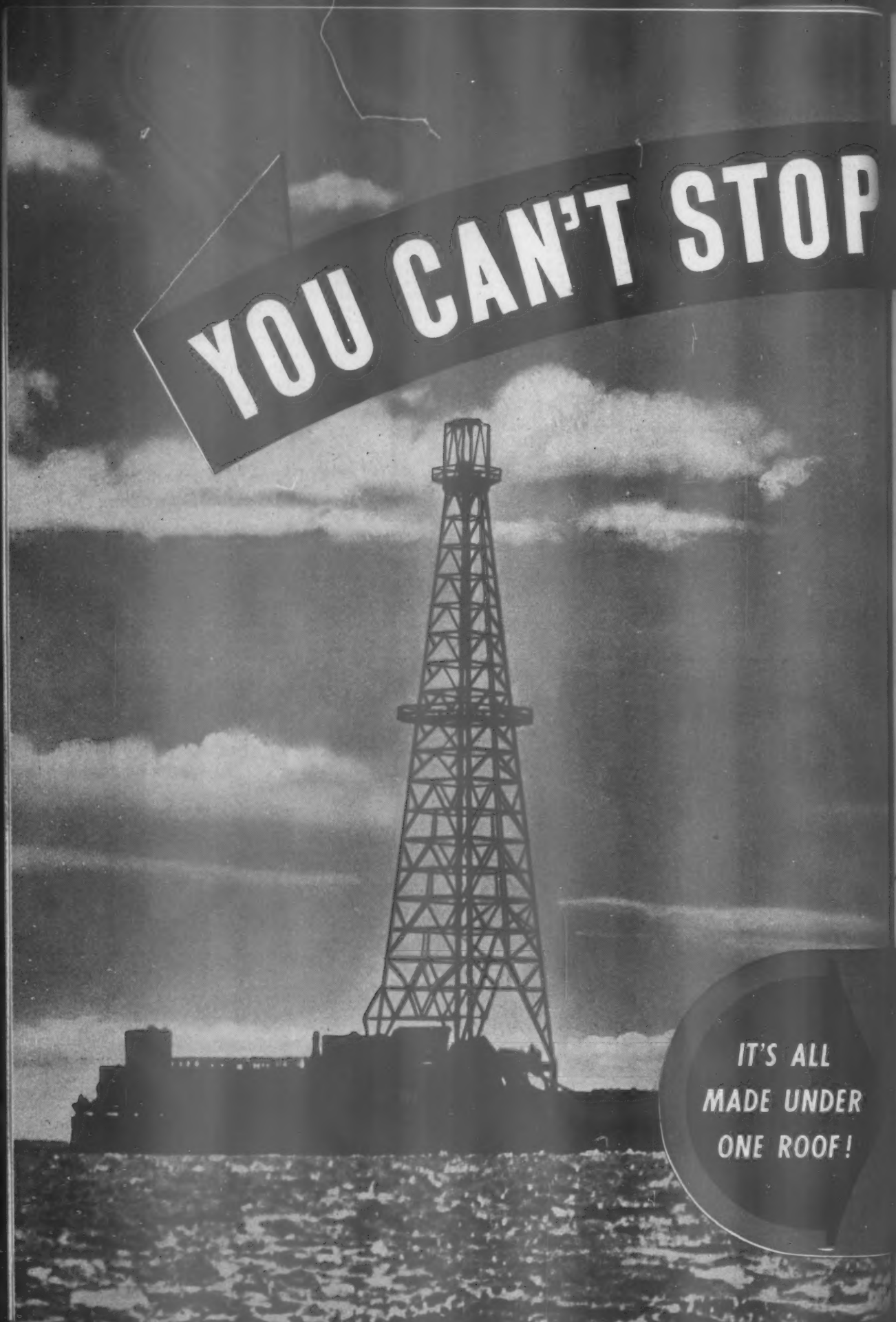
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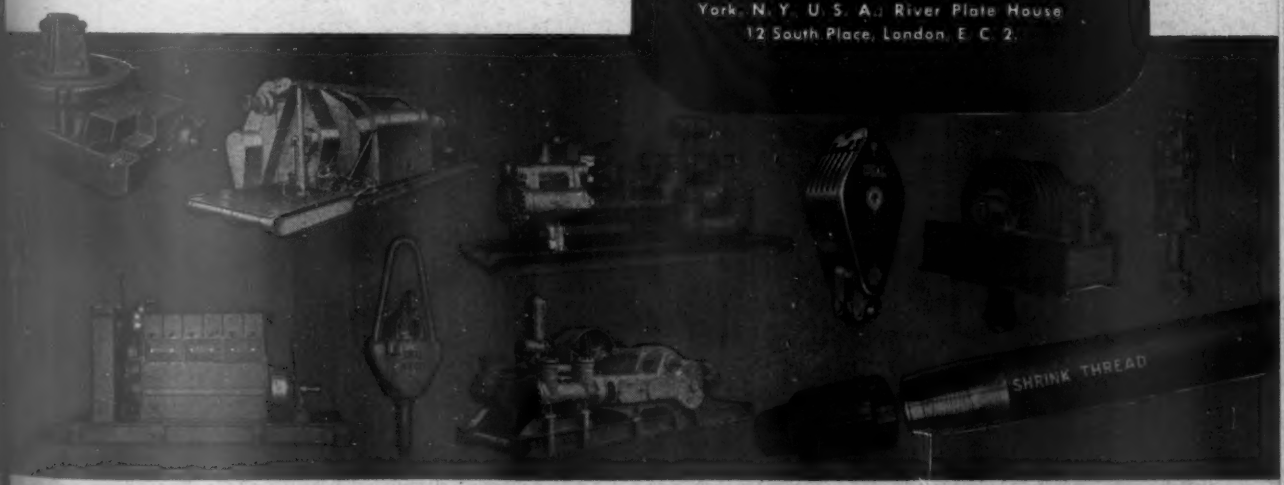


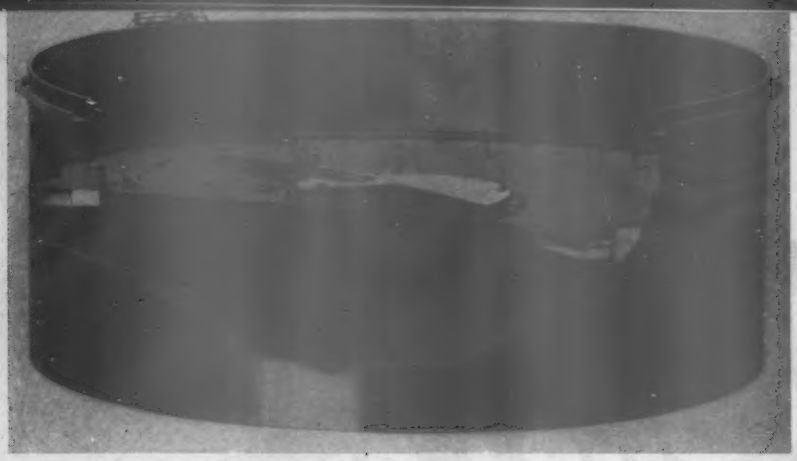


Fig. 1: Cutaway view of high-deck Wiggins pontoon floating roof with center pontoon

Petroleum Conservation Demands Modern Storage Equipment

by F. L. Goldsby*

THE great demand for petroleum products created by the war has served to emphasize the real need for conservation of these vital war materials from production to final use in mechanized war equipment. Conservation is necessary not only in the wise use of finished products by our civilian population (controlled by rationing) and armed forces, but most important in the petroleum-transportation, storage and refining industries themselves. The petroleum industry's greatest step in the direction of conservation is reduction of leakage and evaporation losses. This is important not only to conserve volume but to preserve the quality of the product since the more valuable light hydrocarbons are the first to evaporate.

Evaporation loss from a storage tank may be defined as loss of liquid due to vaporization at the liquid surface. Depending on the way the vapor is expelled from a closed container, evaporation losses are usually divided into four classes as follows:

Windage loss which is caused by the circulation of air currents in and out of the vapor space causing vapors to be carried out of the tank.

Breathing loss caused by thermal expansion from atmospheric temperature changes.

Filling loss resulting from the displacement of vapor when the tank is being filled.

Boiling loss due to rapid vaporization that takes place when any part of the liquid reaches the boiling temperature.

Most of the volatile liquids can be divided into two classes. The first includes those liquids of relatively low volatility that do not boil at normal tank-storage temperatures. Practically all crude oils, motor and aviation gasolines fall in this group. The second group includes liquids of higher vapor pressure which may be expected to boil intermittently or continuously, depending on temperature

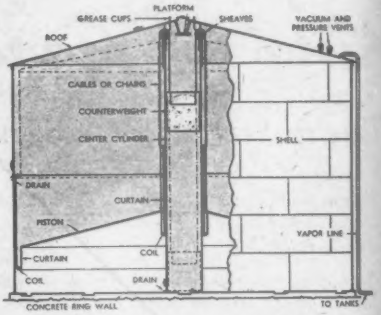
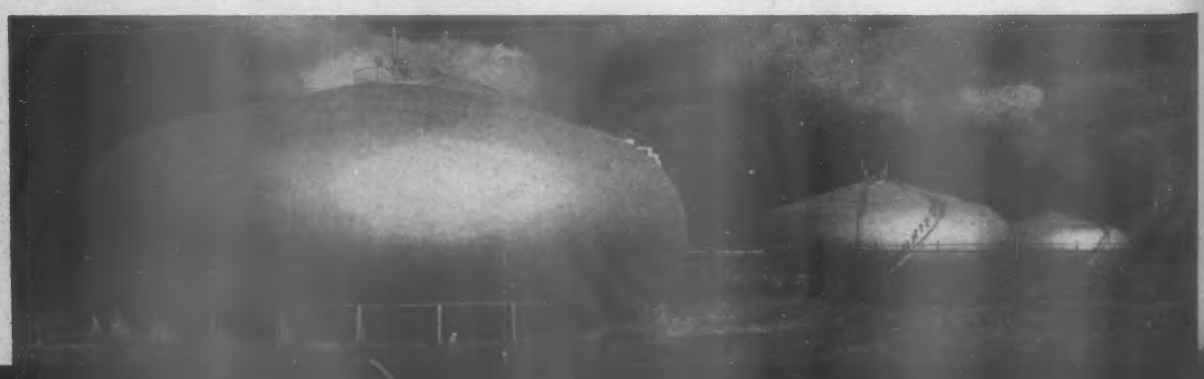


Fig. 2: Sketch showing construction of a new Wiggins piston balloon. Dotted lines show high position of piston when balloon is empty

Fig. 3 (Above): Four 25,000-bbl. 15-lb. plain Hortonspheroids. Fig. 4 (Below): Group of 80,000-bbl. noded Hortonspheroids. One in foreground is designed for 10-lb. gas pressures. Two in background are designed for 15-lb.-per-sq.-in. pressure



*Chicago Bridge & Iron Co.

conditions. Most natural gasoline and liquefied petroleum gases such as butane, pentane, etc., are included in this group.

Modern welded storage containers have been developed and are now widely used to effectively reduce or eliminate evaporation losses of all four types. Some of the most recent developments will be briefly described in the following paragraphs.

Windage loss which occurs chiefly in the older tanks not equipped with gas-tight roofs and conservation vents can of course be prevented by making the roof seams gas-tight and providing conservation vents set for about ½ oz. per sq. in. pressure or vacuum. Practically all fixed roof tanks now being built are thus equipped.

Breathing losses can best be reduced or eliminated entirely by either of three modern developments. First, by providing a variable vapor space into which the air-vapor mixture may expand as temperature increases and from which it is reabsorbed at the liquid surface when the temperature decreases. The second method is to eliminate the vapor space by the use of a Wiggins floating roof. The third method and one which will also eliminate practically all filling losses is that of providing a low-pressure vapor-storage holder into which the vapor space of one or more tanks may be connected.

A variable vapor space can be provided by the use of the well-known Wiggins breather roof, Wiggins balloon roof or a lifter roof. The breather roof consists of a flexible steel diaphragm across the top of the storage tank. It is attached at the periphery to the top of the tank shell. When the roof is in the down position, the plates rest on the special framing. They are not fastened to this framing, however, and are thus free to flex up or down to accommodate vapor volume changes resulting from temperature fluctuations.

The balloon roof operates on the same principle as the breather roof but has been designed to have sufficient capacity to prevent all breathing losses not only on full standing tanks but also on tanks which are frequently filled and emptied. The balloon roof extends beyond the tank shell in order to secure this greater volume. It is attached at the edge to a vertical rim which in turn connects to a substantially horizontal plate extending outward from the top of the tank shell. The main diaphragm flexes up and down in the same manner as a breather roof.

Perhaps the best known and most widely used of all vapor saving equipment is the Wiggins pontoon floating roof which eliminates the tank vapor space thereby reducing windage, breathing and filling losses to a minimum. A cutaway view of the latest high-deck pontoon floating roof is

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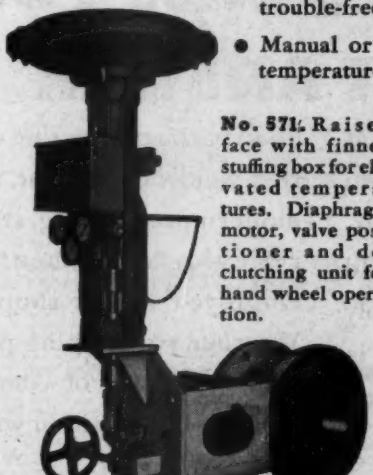

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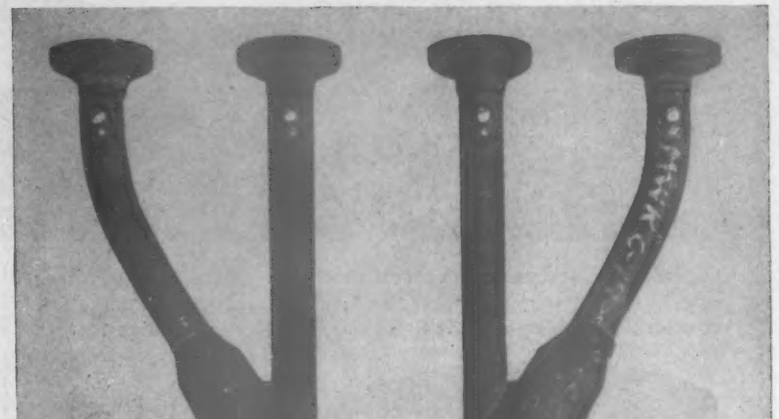

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shown in Fig. 1. This improved design provides a clear unobstructed deck which reduces maintenance costs, provides for better deck drainage and greatly reduces the water load which may collect on the roofs while floating and while on its supports. On tanks less than 60 ft. in diameter the center pontoon on top of the deck is omitted.

The fire protection afforded by a floating roof is an important factor since it eliminates the conditions which permit the contents of the tank to burn. The liquid beneath the deck cannot become ignited because there is no oxygen present to support combustion. Since floating-roof tanks have open tops, an explosive mixture never forms above the roof because there is nothing to confine the vapors to this area.

Since the war, scarcity of material has made it necessary to use old fixed-roof tanks for the storage of large supplies of aviation gasoline. For such a necessary product it is essential that evaporation losses be held to a minimum not only due to value of the vapors but to prevent deterioration of the gasoline through loss of quality and octane number. The new Wiggins piston balloon shown in Fig. 2 provides a means of storing such vapor or gas in a dry space at a very low pressure, usually less than ½ in. of water. This almost pressureless operation makes the piston balloon particularly adaptable for providing vapor expansion space for old existing cone roof tanks that will not stand more than an inch or so of pressure.

The piston balloon consists of a cone-shaped, light-weight steel diaphragm or piston operating inside a cylindrical steel shell. The space between the piston and shell is sealed by means of a flexible synthetic rubber-coated fabric curtain. The piston is counterweighted so that it takes only a very slight pressure to move it. On large size (over 30,000 cu. ft. capacity) piston balloons, a center cylinder which also serves as a roof support is used. The space between the inner edge of the piston and the center cylinder is also sealed with

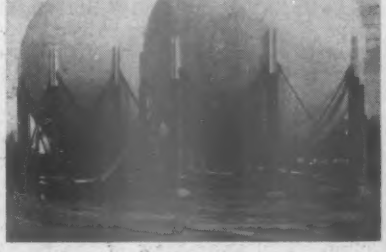

Fig. 5: Group of Hortonspheres

a fabric curtain. There are no liquid seals to heat in cold climates or other continuous operating costs. All operating parts are located inside of the main shell and protected from the weather. This new design has made large-capacity piston balloons possible and into which the vapor space of several large tanks can be connected. As rising temperatures cause the vapor in the tanks to expand, or as oil is pumped into the tanks, the excess vapor flows into the balloon. When conditions are reversed the vapor in the balloon flows back into the tank.

Piston balloons can also be used as storage holders for other types of gases used in the petroleum field or related industries.

Breathing and boiling losses can be entirely eliminated and filling losses reduced to a minimum or eliminated entirely by the use of pressure storage. While usually thought of in terms applying to volatile liquids of the second group, low-pressure vessels such as the Hortonspheroids are one of the most economical types of containers for storage of aviation and motor gasoline.

The Hortonspheroid, Figs. 3 and 4, is a modern, streamlined pressure vessel and designed to eliminate all evaporation losses for those products ranging in volatility from aviation and motor gasoline to natural gasoline. They are built in capacities of 2,500 bbl. to 100,000 bbl. or more and for gage pressures of 2½ to 40 lb. per sq. in. The spheroidal shape is the natural shape to resist the stresses due to the combination of the liquid load together with a small internal gas pressure. A substantial saving in material is made possible by the use of this spheroidal form since all the plates in the shell of the container including those in the roof and the bottom are stressed in tension and are thus effective in resisting pressure.

For products requiring higher gage pressures to prevent boiling losses, the gas pressure becomes the dominating design factor and the ideal shape of the vessel approaches the sphere. The Hortonsphere, Fig. 5, is the result and is a spherical pressure vessel used to provide economical storage for products ranging from the most volatile natural gasolines up to butane, pentane and other liquefied petroleum gases. Hortonspheres have found wide application for use in storing of charge stocks and butadiene in recently built plants for the synthetic rubber program.

Pressure vacuum relief vents, gaging and sampling devices and other operating equipment have likewise been improved and redesigned to keep pace with the changing trend in storage containers. It is therefore possible to provide a completely equipped modern storage container for every purpose.

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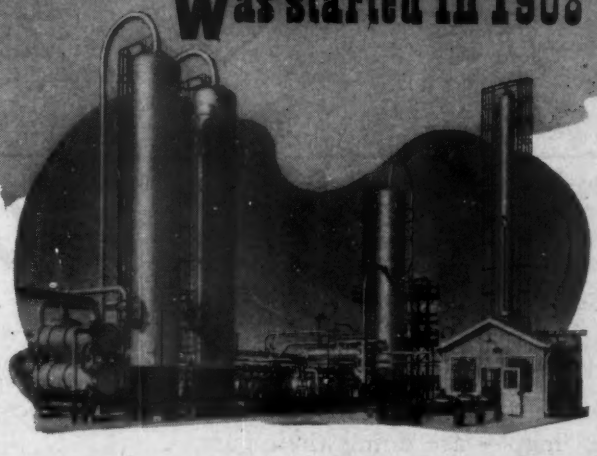

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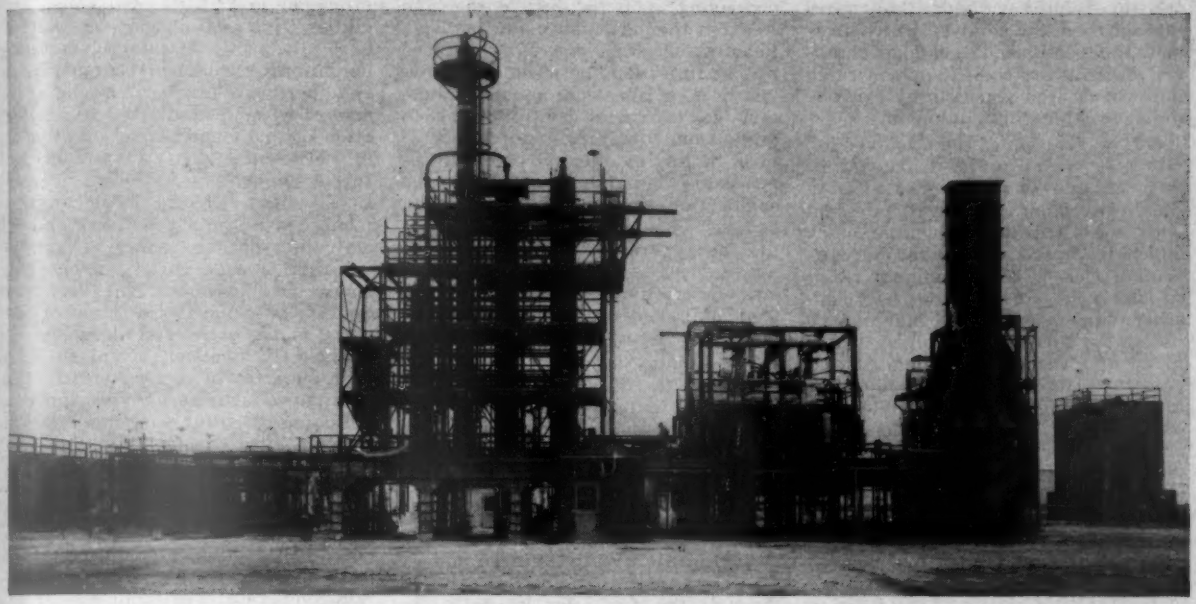


Fig. 2: Phillips Petroleum Co. Cycloversion, catalytic-cracking unit, in which the Cycloversion process has been developed

Gas-Oil Cracking by the CYCLOVERSION PROCESS

by Walter A. Schulze and C. J. Helmers*

THE problem of production of still larger quantities of high-octane motor fuel appears vital, because plans must be made now for tomorrow's needs. If the war should continue, additional supplies of high-octane fuels will be required. If peace should come soon, then these same high-octane motor fuels will be needed for reestablishing our economy. It therefore seems appropriate to present experimental information on the Cycloversion process — a process developed by Phillips Petroleum Co. for the concurrent manufacture of high-grade motor fuels and highly olefinic fractions by the catalytic cracking of naphthas and heavy oils.

Flow Diagram and Process Description

The catalytic cracking of gas oils and naphthas has been investigated in both pilot-plant equipment and in a large semicommercial plant for the purpose of determining the fundamental relationships existing between processing conditions, catalyst activity, and the characteristics of the products obtained through such catalytic operations. It has been necessary to study the relationship of each process variable over a wide range of conditions because of the numerous and broad ramifications of the catalytic-cracking reactions.

*Research department, Phillips Petroleum Co.

Catalytic cracking of gas oils by the Cycloversion process produces high yields of high-quality motor fuels plus substantial quantities of light olefins. The process employs fixed-bed catalyst chambers of unique design. The vessels are refractory lined and contain a plurality of beds separated by vapor spreaders connected to ports in the side of the vessels at suitable levels. Endothermic or exothermic reactions may be controlled during the process cycle by adding suitable gas streams through these injection points. Also, through these ports, reactivation gas is supplied. A Cycloversion plant is exceedingly flexible. This flexibility results from the allowable wide range of operating conditions, which include pressure, temperature, flow rate, and length of process cycle. Catalytic-cracking temperatures have been varied from 900° to over 1,200° F. and process periods are typically of 3 to 6 hours' duration.

The Cycloversion experimental tests to be discussed here have been directed along two major lines of investigation:

1. The conversion of gas oil with high yields of highly olefinic high-octane motor fuel.

2. The conversion of gas oil and naphthas into light olefinic hydrocarbons with concurrent production of high-octane motor fuel.

In its basic aspects the Cycloversion plant consists of a preheater and two or more catalyst chambers. The heater is of conventional design and is used merely to vaporize and heat the feed stock to the desired temperature with a minimum of thermal decomposition. The hydrocarbon vapors are diluted with steam, superheated to the desired operating temperature and are passed at moderate pressures

and at relatively high flow rates through beds of catalyst which promote the reactions. The catalyst chamber effluents are cooled and separated into the desired products by conventional fractionating equipment.

A flow diagram of the Cycloversion unit is shown in Fig. 1. Steam or other diluent gas is preheated in a short convection coil and is combined with the hydrocarbon charge stock which is vaporized in a second convection coil. This combined vapor stream is heated to the desired operating temperature in the radiant section of the furnace. The mixed vapors then enter the catalyst chamber and pass in series flow through the plurality of catalyst beds. Sensible heat is recovered from the hot effluent vapors in a waste heat exchanger. Provision is made to introduce either hot or cold diluent gas at points between the several catalyst beds as a means of controlling the temperature. Thus, superheated diluent may be injected between beds to raise the temperature of the reacting vapors if the reaction in the catalyst bed is of an endothermic nature. Similarly, the vapors and beds may be held to a desired temperature during an exothermic reaction by injection of cool diluent or quench gas. A selected temperature gradient may thereby be established when desired. This positive reaction temperature control of the catalyst mass is a primary feature of the Cycloversion process.

In reactivating the catalyst mass the carbon deposited during the oil processing is burned off by introducing a controlled amount of air together with a diluent which serves to carry off heat generated by the combustion. The diluent may be either steam or recycle combustion gas, depending upon the cost of fuel and steam at the particular plant involved. Reactivation time is greatly reduced by the injection, between the catalyst beds, of air-steam or air-combustion gas mixtures controlled as to proportion, quantity, and temperature. In this manner all beds are regenerated simultaneously, and the combustion gases from a regenerating bed serve as additional diluent for the beds directly beneath it. The waste heat exchanger recovers a large proportion of the sensible heat from the regeneration process and effects a saving in steam costs.

The unique design of the catalyst chambers, the disposition of the catalyst beds within the chamber, and the special provisions for distribution of the flowing streams make possible the realization of the inherent advantages of the fixed-bed catalyst.

Among the advantages of the Cycloversion fixed-bed catalyst as contrasted with moving catalyst masses are (1) no appreciable loss of catalyst through the formation of fines by abrasion; (2) elimination of equipment for the circulation, separation, and recovery of catalyst from the process or reactivation gases; (3) flexibility in permissible operating pressures over a relatively wide range, and (4) no apparent tendency for high-boiling, nonvolatile reaction products to condense upon and bond the catalyst since contact between catalyst and reaction products is limited to relatively high temperature zones.

The flexibility of the equipment used for the Cycloversion process, particularly with regard to the catalyst chamber design and the means provided for control of temperature and conversion, is a great aid to the efficiency and utility of the plant facilities. This flexibility is demonstrated by the fact that catalytic-cracking operations have been changed from endothermic to exothermic type of reactions without any substantial alteration of plant equipment or processing efficiency. The adaptability of the equipment to different conversions with different heat requirements during both processing and reactivating periods makes it possible to utilize a wide variety of charging stocks and to obtain the type and quality of products in greatest demand at any particular time.

The Cycloversion catalysts are characterized by long service life, maintained activity and resistance to poisoning by sulfur compounds, steam, and the like. The fact that the catalysts are not adversely affected by steam makes it possible to employ steam-air mixtures or inert recycle gas systems containing steam for reactivation. Moreover, the catalysts are able to withstand high reactivation temperatures without loss of activity. Operation in the semicommercial plant has demonstrated that catalyst costs will be exceptionally low.

The length of the process period and, hence, the frequency of reactivation for a catalyst chamber usually depends on the nature of the charge stock and the products desired. Thus, process periods for Cycloversion of gas oils to motor fuels range from 3 to 6 hours or longer. Because of these long process periods, cycle timing and automatic switching equipment are not required.

Yields from Cycloversion are ordinarily based on a once-through operation, because the refiner usually finds it desirable to integrate his thermal and catalytic cracking operations in a manner most suitable to the thermal-cracking equipment already on hand. Yields of gasoline and of light olefins can be increased by recycling to the catalytic unit and the unconverted portion of the catalytic naphthas and gas oils. The yield of gasoline from catalytic cracking of recycle gas oil is quite good and the quality of the product excellent, but in many instances the refiner will find it advantageous to use present thermal-cracking equipment for further conversion of catalytic recycle stock.

Experimental Data

For the most part, pilot-plant studies of the operating variables have covered a broad range, especially with respect to flow rate, temperature, pressure, length of process cycle and carbon deposition. On the other hand, the semicommercial plant has been used to study engineering problems and to check the pilot-plant results. Excellent correlation has been obtained between the pilot plant and semicommercial scale data.

The semicommercial unit is com-

Fig. 1: Simplified flowchart of Cycloversion process shows the main features, fixed-bed catalyst, in situ regeneration, simplicity of design

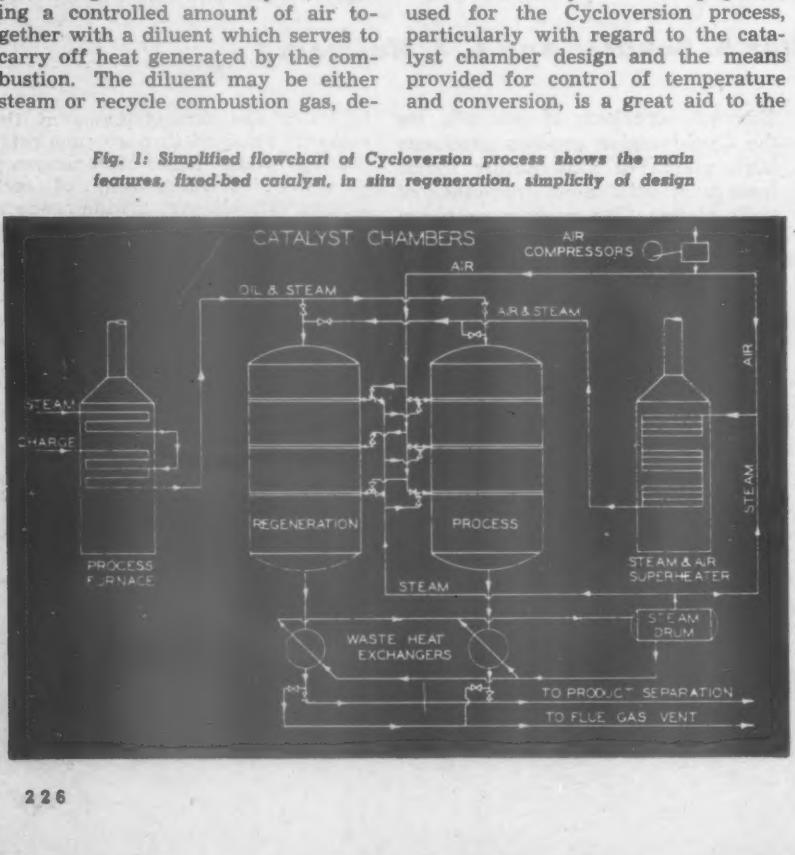


TABLE 1—CHARACTERISTICS OF TYPICAL GAS-OIL CHARGE STOCKS

Gas oil	Source—	A.S.T.M. distillation, °F. I.b.p.	10%	50%	90%	Gravity, °A.P.I.	Pour point, °F.	Sulfur, %
A	Panhandle	254	530	640	710	36.4	70	0.36
B	Mid-Continent	282	511	589	707	35.6		0.29
C	Mid-Continent	542	624	686	737	31.5	70	0.37
D	Mid-Continent	450	504	558	605	37.3	15	0.17
E	Mid-Continent	438	468	500	538	39.5	..	0.09
F	Mid-Continent	500	527	545	575	37.6	..	0.14
G	Mid-Continent	565	578	597	625	34.1	..	0.24

TABLE 2—EFFECT OF FEED STOCK ON OCTANE NUMBER OF BUTANE-FREE GASOLINE

(6-hour process period)

Gas oil	Oct. No. without TEL A.S.T.M.	Research	Reid vapor pressure	Bromine number	Olefin content, weight %	Sulfur content, weight %
A	75.0	86.1	5.3	91	65	0.074
B	78.2	94.2	5.6	123	88	0.053
C	75.9	87.6	5.1	114	81	0.050
D	78.1	91.6	5.9	120	85	0.031
E	79.4	92.4	5.6	112	78	0.035
F	80.1	94.8	5.0	123	86	0.042
G	79.4	92.4	5.6	126	88	0.051

TABLE 3—COMPOSITION OF LIGHT GASES FORMED DURING CYCLOVERSION OF GAS OILS

Conversion:						
Liq. vol. per cent	33.3	42.8	79.8	30.1	43.7	59.3
Weight per cent	32	41	78	29	42	57
Steam/gas oil, moles	4	1.5	7	No steam		
Steam, lb. per bbl. of charge	83.8	32	256			
Composition, mol per cent:						
Hydrogen	18.2	14.5	19.4	17.5	10.7	9.2
Methane	20.6	22.7	25.3	21.6	25.4	27.2
Ethylene	10.0	10.8	11.8	5.6	7.2	5.3
Ethane	15.5	15.4	13.6	16.7	16.6	19.5
Propylene	13.2	11.5	10.6	9.7	11.0	9.8
Propane	9.6	11.7	7.2	12.0	12.4	13.5
Butylenes	9.1	7.9	8.6	9.9	9.4	8.9
Butane	3.8	5.5	3.5	7.0	7.3	6.6

plete in that storage facilities, fractionators, clay-treating tower and all accessory equipment have been provided. A photograph of this plant (Fig. 2) gives an idea of the scale on which this operation has been conducted.

Characteristics of representative gas-oil charge stocks used in the experimental investigation of motor-fuel production are given in Table 1. These various gas-oil stocks have been used in pilot-plant or in semicommercial-scale investigations to obtain comparative data on feed stocks of differing distillation characteristics and hydrocarbon composition. In this manner the specific conditions of processing best suited to given feed stocks have been determined.

Charge Stocks for Cycloversion Cracking

Perhaps the most fundamental question in the mind of every refiner relates to the kind of charge stock suitable for catalytic cracking. In other words, is the process limited to gas oils of certain specific characteristics, or can high-quality products be produced from a wide variety of charging stocks? It may be stated rather conclusively that a Cycloversion plant can operate successfully on almost any naphtha or gas oil and that high-octane products can be made from such stocks. Obviously, the optimum operating conditions will vary appreciably with the characteristics of the feed. Considerable technical information has been accumulated on this phase of the subject.

The data in Table 2 show the octane ratings of butane-free gasolines obtained from the typical gas-oil charge stocks defined in Table 1. These ratings were obtained on the composite products made with process periods of 6 hours duration. It should be noted that the vapor pressures are very low and that addition of butane or vapor recovery gasoline to make up the vapor pressure deficiency will further increase the octane ratings. The values given here do not by any means represent the highest octane number products obtainable but are representative of products which can be made in high yield from the respective charge stocks when operating the plant for relatively high throughput.

Particular attention is directed to the high olefin content of these catalytic gasolines. In the examples of Table 2, the concentration of olefins ranges from 65 to 88 weight per cent. As might be expected from these olefinic gasolines, the octane ratings by the Research method are exceptionally high, ranging from 86 to 94 without the addition of tetraethyl lead. The difference between the A.S.T.M. rating and Research rating, sometimes defined as the sensitivity of the fuel, falls in the range of 11 to 16 octane numbers. Excellent road performance can be obtained from the catalytic gasolines produced by the Cycloversion treatment.

Product Yields

The products from Cycloversion treatment of gas oils are normally reported under five headings: (1) dry gas, (2) butane-butylenes, (3) butane-free gasoline, (4) recycle stock, and (5) carbon. Dry gas is defined as propane and lighter hydrocarbons. Gasoline is the liquid product composed of pentanes and heavier hydrocarbons boiling below 400° F. Recycle stock is defined as that portion of the condensed effluent product boiling above 400° F. and contains heavy naphtha fractions as well as unconverted gas oil.

The light hydrocarbons produced by the Cycloversion of gas oils at relatively low temperatures are characterized by the high proportion of olefins produced. Table 3 shows a series of typical gas analyses of the products from Cycloversion of a gas oil at 75 lb. pressure and at temperatures of 980° to 1,050° F. Tests with and without steam diluent are included to show the effect of steam on olefin production.

Depth of Conversion

Tables 4 and 5 show typical data for the characteristics and yields of reaction products from the Cycloversion treatment of gas oil when cracking at (1) moderate and (2) deep per pass conversion. The depths of conversion, 36 and 80 per cent respectively, were controlled by varying the pressure, temperature, oil rate, or diluent ratio, while the length of the process period was held at 3 hours. Depth of conversion intermediate to those shown will, in general, effect product yields intermediate to those indicated.

Table 4 shows the approximate operating conditions which were used to obtain these particular low and high per-pass conversions. These operating conditions, however, are not rigid and may be varied considerably to produce equivalent conversions. The reaction products obtained from the chosen operating conditions are also shown in Table 4. It should be noted that the more severe operation approximately doubled the conversion while the dry-gas production was increased about sixfold. Attention should be directed, also, to the fact that the C_4 fraction, produced by the Cycloversion of gas oil, contains between 70 and 80 per cent butylenes and the C_3 fraction from 60 to 80 per cent propylene. Gasoline yields are reported as (1) stabilized 6 lb. R.v.p. (or essentially butane-free) gasoline; (2) stabilized gasoline pressured to 10 lb. R.v.p. by the addition of normal butane.

The yield of gasoline varies considerably, depending upon the depth of conversion. Lower gasoline yields are associated with deeper conversions since a portion of the gasoline itself is converted to gases and carbon at the more severe operating conditions. The characteristics of the stabilized (6 lb.) gasoline produced by this catalytic cracking of gas oil are shown in

Table 5. The unleaded gasoline produced under the milder operating conditions rated 78.6 octane number by the A.S.T.M. method and 91.3 by the Research method. The gasoline produced under the more severe conditions rated 81.8 A.S.T.M. and 95 Research octane numbers.

Comparison of the yields of single-pass and two-pass Cycloversion of gas oils is shown on Table 6. These data indicate that a two-pass operation will yield a higher per cent of gasoline with a slightly increased octane number than a single-pass operation; however, the main difference is in the rate of carbon formation. This means that the highest efficiency of operation usually results from moderate per-pass conversion with the unconverted (more refractory) portion of the oil then being treated separately. If internal recycling is practiced by treating a mixture of virgin with recycle stock, the operating conditions should be adjusted somewhere between the optimum for fresh feed and optimum for the recycle stock alone.

The lower carbon deposition of the two-pass operation permits a reduction of about 45 per cent in the air required for reactivation; however, this saving will be offset by an increase in the size of process equipment, such as the catalyst chambers and heating furnaces, process heating and cooling loads, and additional storage facilities if the recycle stock is treated separately. The selection of the best method of operation at any refinery depends to a great extent upon available equipment, the size of the refinery, and the products desired.

High-Temperature Cycloversion of Gas Oil

The preceding data have shown that substantial quantities of light olefins can be produced concurrently with high yields of superior-quality motor fuel. In some refineries even larger volumes of propylene and butylenes may be desirable as feed stocks for alkylation and catalytic polymerization processes. When this is the case, the Cycloversion unit may be operated under conditions which convert gas oils and naphthas into predominantly light olefins with high-octane gasoline as a secondary product. These high yields of light olefins may be obtained by raising the operating temperature to approximately 1,200° F. It is desirable to use high flow rates, low partial pressures and deep conversion to promote the formation of the light olefins. As examples of the conversion of relatively cheap raw material into high-quality alkylation and polymerization feed stocks, data from several Cycloversion tests at high temperature and low pressure are shown in Table 7.

Light gas oil and kerosene were used as charge stocks in these tests. The flow rates were three to four times those used in the low-temperature operations described above for the production of motor fuel.

Although the gasoline produced in this type operation may be of secondary importance, it should be noted that it has high antiknock characteristics. The product from the light gas oil had an A.S.T.M. octane number of 79 and Research octane number of 93.

Plant Equipment

A Cycloversion catalytic gas oil cracking plant may be built entirely from new materials, but it may also be constructed by adding necessary equipment to an existing thermal conversion still. Conventional equipment may be used for the usual preheating, cooling and fractionating steps.

The primary purpose of the preheating furnace is to vaporize the gas oil and raise the temperature of the vapors to the desired reaction temperature as rapidly as possible. To achieve this purpose, steam is combined with the vaporized feed in order to maintain high velocity in the tubes and to supply a portion of the heat which is required for the endothermic cracking reaction. The pressure in the high-temperature section of the furnace should be relatively low, the vapor contact time short, and the vapor temperature curve steep. Under these conditions thermal cracking in the coils is reduced to a minimum. If steam is used in the regeneration, a separate coil is required to superheat steam. To obtain a flexible arrangement for heating the oil vapors as well as the regeneration steam, it may be desirable to build or convert the furnace to a center-bridge wall type with steam coils on one side and oil coils on the other so that either side may be fired independently. The specific design of the furnace is not important so long as the conditions for short residence time are met.

Radiant tubes of 4-6 chrome-moly composition have given very good service in the semicommercial unit even with experimental conditions wherein coil outlet temperatures have gone as high as 1,300° F. and fire-box temperatures up to 1,800° F. Other alloy compositions may be used, of course, as long as they afford protec-

TABLE 4—TYPICAL OPERATING CONDITIONS AND PRODUCT COMPOSITIONS FOR CYCLOVERSION OF MID-CONTINENT GAS OIL

Gas oil rate, bbl./ton catalyst/hour	6		2	
Steam diluent, lb./lb. gas oil	0.50		0.52	
Process period, hours	3		3	
Chamber pressure, lb./sq. in.	35		35	
Catalyst bed temperature, °F.:				
Inlet	1,000		1,050	
Outlet	940		1,014	
Gas oil converted:				
Weight per cent	36		77.5	
Liq. vol. per cent	36.4		79.8	
Component (based on charge):	Cu. ft./bbl.	Liq. vol. %	Cu. ft./bbl.	Liq. vol. %
Hydrogen	46	....	340	....
Methane	57	....	422	....
Ethylene	28	1.52	200	10.71
Ethane	37	2.19	230	13.69
Propylene	58	3.52	175	10.62
Propane	15	1.00	119	7.74
Total dry gas	241	....	1,486	....
i-Butylene	28	1.95	59	4.12
n-Butylene	41	2.93	82	5.83
Butanes	15	1.17	56	4.43
Butane-free gasoline, vol. per cent	....	28.05	....	32.60
10 lb. R.v.p. gasoline*	....	30.3	....	35.4
Recycle stock, vol. per cent	....	63.55	....	20.24
Carbon, weight per cent	....	1.2	....	8.3
Carbon, lb. per bbl. charge	....	3.5	....	24.6

*Calculated by adding n-butane.

TABLE 5—CHARACTERISTICS OF STABILIZED CYCLOVERSION GASOLINE FROM MID-CONTINENT GAS OIL

Gas oil converted:				
Liq. vol. per cent	36		79.8	
Weight, per cent	36		77.5	
Reid vapor pressure	5.9	*10.0	5.7	*10.0
A.S.T.M. octane number:				
0 cc. TEL	78.6	79.5	81.8	82.3
1 cc. TEL	81.4	83.3	84.4	86.0
Research octane number:				
0 cc. TEL	91.3	91.4	95.0	95.0
1 cc. TEL	94.2	94.3	97.6	97.6
Gravity, °A.P.I.	54.2	....	47.5	....
A.S.T.M. distillation, °F.:				
First drop	98	....	100	....
10 per cent	141	....	146	....
50 per cent	251	....	256	....
90 per cent	371	....	368	....
End point	405	....	400	....
Refractive index	1.4362	....	1.4492	....
Bromine number	112	....	80	....

*Calculated values from adding n-butane.

TABLE 6—COMPARISON OF SINGLE-PASS AND TWO-PASS CYCLOVERSION OF HEAVY GAS OIL

	First pass	Second pass	Two-pass*	Single-pass
Operating conditions:				
Flow rate, V/V/H	0.80	0.93		1.02
Steam/oil, weight	0.55	0.58		0.21
Temperature, °F.	985	965		985
Process period, hours	6	6		6
Conversion:				
Weight per cent	37.5	23	52	53.5
Liq. vol. per cent	38.2	23.9	53	55.5
Butane-free gasoline:				
Yield, vol. per cent charge	28.5	15.8	38.4	34.0
Yield, vol. per cent oil converted	74.5	66.1	72.5	61.2
A.S.T.M. octane number	76.6	75.8	76.3	75.9
Carbon, weight per cent of charge	0.95	1.2	1.8	2.8

*Based on virgin gas oil feed.

TABLE 7—OLEFINS BY HIGH-TEMPERATURE CYCLOVERSION OF HEAVY OILS

	Feed stock		
Operating conditions:	Light gas oil	Light gas oil	Kerosene
Catalyst temperature, °F.	1,190	1,200	1,205
Chamber pressure, lb./sq. in.	6	7	2
Flow rate, bbl./ton catalyst/hour	19.5	17	18
Steam, lb./lb. oil	0.23	0.42	0.18
Steam, lb./bbl. of charge	67.5	123	51
Process period, hours	2	6	6
Conversion:			
Weight, per cent	73	64	71
Vol. per cent	76	67	73.4
Products, vol. per cent charge converted:			
Ethylene	27.2	29.8	26.0
Ethane	16.3	14.4	9.9
Propylene	19.1	21.9	21.4
Propane	5.6	3.7	3.5
Butadiene	2.7	2.7	3.8
Butylenes	12.1	12.7	15.2
Butanes	1.4	1.7	1.7
Debutanized gasoline	42.8	47.4	37.2
Carbon, weight per cent of charge	2.4	1.4	2.1
Carbon, lb. per bbl. charge	7.0	4.1	6.0

tion against oxidation and corrosion.

The catalyst chamber shell is constructed of low carbon steel. The insulation is a refractory material which is cast inside the vessel to a thickness of 6 to 9 in. in such manner that a high-temperature gradient is established through the chamber lining. This permits shell temperatures of the vessel to remain far below the maximum service temperature of even low carbon steel while regeneration temperatures of 1,350° to 1,400° F. can be utilized in the catalyst bed.

The catalyst mass is held in the chamber by means of an alloy screen across the bottom of the chamber. The catalyst is dispersed into a plurality of beds as shown in the flow diagram, Fig. 1, separated by vapor spreaders entering through the side of the chamber at the desired levels.

Regeneration of the catalyst in catalytic-cracking processes is of particular importance since the rate of carbon removal defines the capacity of the unit under a given set of operating conditions. The efficiency of the regeneration directly affects the economy of the catalytic process, because carbon removal represents both investment and operating costs. Regeneration of the catalyst in the Cycloversion process is accomplished by introducing air into the catalyst chamber after hydrocarbon vapors have been swept out by a steam purge. In order to control the temperature rise which results from the combustion reaction, the air is diluted with either steam or combustion gas which serves to carry away the heat from the combustion zone and out of the chamber. The choice of diluent used in the regeneration process is determined primarily by economic features. Where fuel and steam costs are low, steam is the most satisfactory diluent. If combustion gas serves as the diluent, the inert gas leaving the regenerating chamber may be recycled by means of a hot gas blower with the desired proportion of air being added to it. When steam is used as the diluent, it is not recirculated but passes through a waste heat exchanger where the sensible heat gained in the regenerating zone is recovered.

The injection of cool steam and air at points along the side of the catalyst chamber has the effect of dividing it into a number of individual zones in which regeneration is carried on simultaneously. As an example, cool steam and air are injected through the first port indicated in Fig. 1. The steam-air mixture which entered the top of the catalyst chamber and passed through the first bed has been denuded of oxygen and has been raised to a temperature of 1,350° to 1,400° F. As it passes the injection port, the temperature is reduced to about 1,000° F. by the cool gas entering the injection port. Air is added simultaneously with the injection steam so that the second bed is also regenerated, and the heat is carried away by the steam supplied both at the top and at the side of the chamber. The particular advantages of this feature are (1) great reduction in reactivation time effected through the use of these multiple burning zones in the chamber; (2) reduction in total steam requirement since much of the steam is used repeatedly in conjunction with additional cool steam to remove heat from several different burning zones while passing through the catalyst chamber; and (3) small pressure drop in the chamber.

In order to insure ignition of the carbon, the air-diluent stream entering the bed is held at a temperature of 900° to 1,100° F. After combustion is initiated, this temperature may be reduced to some extent. In general, it is advantageous to maintain the temperature of the regeneration gas entering the top of the chamber at the oil process temperature so that the catalyst bed temperatures will be lined out for the next oil-processing period.

Utilization of the Cycloversion Process

From the previous discussion on the complexities of the catalytic cracking process, it might be adjudged that a Cycloversion plant is complicated. On the contrary, Cycloversion can be utilized in even the smaller refineries because the plant is exceedingly flexible and may be operated on a wide variety of charge stocks. This means, too, that the plant may be readily adapted to the manufacture of products differing widely in characteristics. Such flexibility is obviously desirable in plants being built for the future.

Where catalytic cracking is to be combined with present thermal operations, the catalyst chambers and regeneration system constitute the principal new construction. Present facilities with respect to (1) preheating the gas oil, (2) fractionation of the catalyst chamber effluents, (3) gas recovery plant, and (4) treating equipment are usually adequate for processing the same amount of crude oil per day. If the "bottlenecks" are removed, then it may be possible to increase the over-all capacity of the plant at relatively low investment for the incremental increase in production.

No attempt will be made here to go into the matter of investment and operating costs for Cycloversion plants since costs are dependent upon (1) existing operations, (2) equipment available for conversion from thermal to catalytic service and (3) the products to be manufactured. Each situation should be thoroughly evaluated with current operations in the refinery being given full weight. The simplicity of the operation itself confirms the statement that Cycloversion constitutes a highly efficient and economic process for the production of high-octane motor fuels.

General view of Porocel Corp. plant at Berger, Ark. Isocel plant is at left, and Porocel, Driosel and Cyclocel plant at right

Bauxite as an Adsorbent, Catalyst, And Catalyst Carrier

*by H. L. King, Jr., C. D. Laughlin, and H. M. Gwyn, Jr.**

BAUXITE, an aluminous rock, has been of great importance for many years as the chief ore source of metallic aluminum and aluminum salts. Commercial use as a source of adsorbents, catalyst carriers and catalysts, however, dates back only to 1936, when a granular activated bauxite was offered to the petroleum refining industry under the trade name Porocel, chiefly as an adsorbent for lubricating-oil purification.

This study of bauxite and its uses in petroleum refining technology as a catalyst and catalyst carrier or support, is presented in two installments. The first installment sums up the application of bauxite in older processes, such as in the form of Porocel, a decolorizing purifying agent. The second installment will appear in an early issue.

Research had made excellent progress in establishing the physical and chemical properties of this unique material as an adsorbent by the time the United States had entered the present war. Its general value in the catalysis of petroleum hydrocarbons had been demonstrated and its use as a refining agent in the purification of

*Porocel Corp.

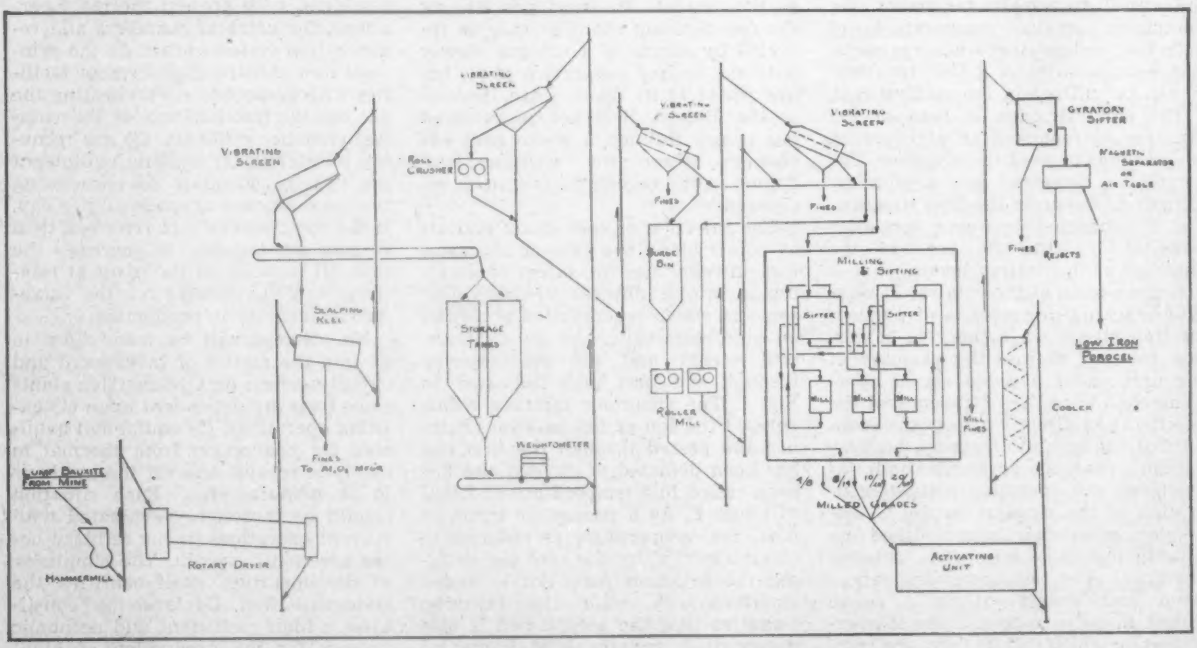


Fig. 1: Flow sheet of preparation of Porocel activated bauxite

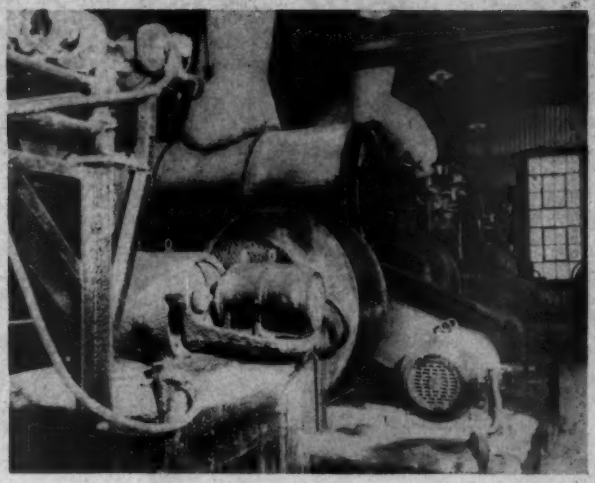


Fig. 2 (Left): Roller mill reduction equipment, bauxite milling and sifting unit. Fig. 3 (Right): Rotating pressure impregnators used in isomerization catalyst manufacture in the Isocel plant

saccharine liquids had been commercially established.

War needs forced concentration on specific problems related to national defense, particularly those involved in the production of 100-octane aviation gasoline. It is the purpose of this article to briefly outline the general methods involved in manufacture of bauxite adsorbents and to indicate the specific use developments already translated to industrial practice, with some indication as to where these use developments enter into forward thinking.

Bauxite, like most ores of commercial import, is never easily accessible, and in the State of Arkansas, the present sources of Porocel ore occur from 50 to 200 ft. below the surface. Mining is by shaft-and-tunnel and open-pit methods, equipment development now permitting economic removal of overburden to depths of 100 ft.

The selection of bauxite for use in chemical and aluminum manufacture is chiefly determined by chemical analysis. Adsorbent and catalyst requirements, however, necessitate consideration of all the following criteria:

1. A high alumina content.
2. Iron content low or susceptible of further reduction.
3. Proper physical structure as regards strength and resistance to attrition.
4. Adsorptive and catalytic specificity.

The specification demanded by one catalytic reaction may be unfavorable for another, and it is necessary to test the suitability of an ore for each of the processes in which it is to be used.

Activated Bauxite Manufacture

The manufacture of activated bauxite involves the use of processing methods and equipment common to the mining, metal ore grading and concentration, flour milling, and heavy chemical processing industries. Laboratory control of the various steps is achieved by adaptation of test methods peculiar to these industries and by the development of other methods dictated by the unique problems encountered in the manufacture and use of this specialized product. The flow sheet (Fig. 1) generally illustrates the normal flow of ore through the steps of crushing, drying, milling and screening, activation, and separation as practiced in the Porocel Corp.'s plant at Berger, Ark.

The selected, crushed ore is heated at 250°-350° F. to remove free water, leaving about 30 per cent of combined water in the ore.

The dried bauxite is then handled through a system of screens and crushers to an operation in which gradual reduction is accomplished by a series of milling and sifting steps. This procedure, which involves four roller mills with corrugated rolls designed to furnish the maximum yields of coarse grades (see Fig. 2) is generally similar to flour mill practice. The intensive handling reduces to a minimum and rejects from the system any soft bauxite present in the original ore.

The milled grades are thermally activated, the temperature employed depending upon the use to which the product is to be put. The fact that the activation temperature exerts a pronounced effect upon the adsorptive and catalytic properties of Porocel is evidenced by the following typical data:

Calcination temp.	Volatile matter (per cent)	Adsorptive capacity in terms of moisture sorption*	Surface area sq. meters per gram
700° F.	7.4	11.8	273
1,000° F.	1.9	7.0	187

*Capacity for producing bone-dry air. Weight per cent water adsorbed.

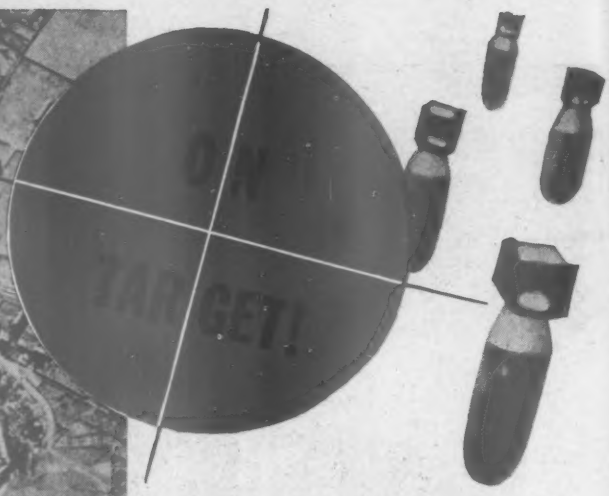
For other purposes, such as for use in butane isomerization guard section duty, the bauxite should be activated at a temperature to give maximum aluminum chloride adsorption and an absolute minimum of water capable of reacting with hydrogen chloride.

The activated bauxite is cooled to about 300° F., preventing moisture pickup and permitting handling in conventional equipment. It is then subjected to final rescreening and deironing. The success of this latter operation depends upon the manner of distribution of iron in the ore and the control of activation. An ore in which the iron is dispersed through the granule does not respond, whereas the presence of most of the iron in discrete particles permits satisfactory separation. Depending upon the use to which the Porocel is to be put, it is either packaged in metal drums, textile bags, or shipped in bulk. The process of manufacture is controlled on a 24-hour basis by laboratory tests, the finished product being tested in most cases for value in its intended field of use.

Manufacture of Isocel (Isomerization Catalyst)

Deironed activated bauxite plus the proper percentage of anhydrous aluminum chloride is charged in approximately 1,200-lb. lots to the impregnators, which are rotating pressure vessels of about 100 cu. ft. total capacity (see Fig. 3). The retorts are headed up, heat applied with the retort revolving, and the temperature raised to slightly above the sublimation point of aluminum chloride. Aluminum chloride and hydrogen chloride fumes which escape from the retort pass to condensers where the aluminum chloride is recovered.

The contents of the retort are cooled and discharged through an enclosed screen to remove fines. The screened product is received directly into full-



CROSS-HAIRS "on" the target . . . bombsig computes drift, speed, bomb-fall . . . indic coincide . . . and it's "Bombs away" . . . lay lethal eggs on a pinpoint. Perfect co-ordinati smooth performance . . . like cementing an well with an Oil Man's cement. Four great ments to choose from . . . each designed to its own job and do it better:

LONE STAR CEMENT for dependable all-around oilfield service;

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open-head drums lined with an acid-proof synthetic.

Each lot is accepted or rejected on the basis of laboratory evaluation of a sample taken with a grain sampler. The laboratory is equipped to run chemical analyses, physical tests (screen analysis, volume weight, volatile matter), and the determination of butane isomerization efficiency by an accelerated technic (see Fig. 4). The isobutane content of the butane-isobutane mixture is determined with an infrared spectrometer, an analysis requiring about 10 minutes.

The usual problems attendant upon the handling of anhydrous aluminum chloride, hydrogen chloride, and mixtures of these vapors have been encountered. Little or no difficulty has been experienced in handling anhydrous aluminum chloride, nor anhydrous hydrogen chloride, although mixtures of molten aluminum chloride and anhydrous hydrogen chloride are very corrosive to steel.

Some idea of the problems resulting from the urgent wartime demand for these catalytic materials can be gathered when it is realized that the Porocel plant has been called upon to deliver roughly four times the quantity of activated bauxite required just prior to outbreak of the war. The Isocel plant was placed in operation just 5 months after ground was first broken, and called upon to deliver twice its designed capacity of a new material on which there was no previous history of commercial production.

Bauxite in the Isomerization of Normal Butane

The deficiency in the quantity of available isobutane for paraffin-olefin alkylation has required the isomerization of the relatively abundant normal butane. Commercial isomerization plants use a catalyst, usually aluminum chloride, with a hydrogen chloride promoter. Early in the present aviation-fuel program, processes isomerizing butane in the vapor phase, and employing an evenly sized activated bauxite as a support for the aluminum chloride catalyst, were adopted. Vapor-phase isomerization, permitting increased production of alkylate, the high-octane constituent of aviation gasoline, has substantially contributed to the present high tempo of aerial warfare now being carried on against the Axis countries.

Two vapor-phase isomerization processes have had several years commercial usage. Both employ activated bauxite as a catalyst support and product purifier, the principal difference between the two processes being essentially that of catalyst preparation. One employs a prepared bauxite-aluminum chloride catalyst ready for use immediately upon being charged to the reaction vessels. The other process charges the bauxite support to the reactors and develops the catalyst in situ by injection of aluminum chloride in vapor form from exterior vaporizers.

Isocel, the manufacture of which has been previously described is available as an operating supply to users of the prepared catalyst. It contains approximately 18 per cent aluminum chloride uniformly adsorbed and dispersed in active form in a selected grade of low iron-bearing bauxite. The particle size of the resulting granular catalyst is controlled within the mesh range and size distribution specifications required by considerations of maximum catalyst activity and minimum vapor pressure loss.

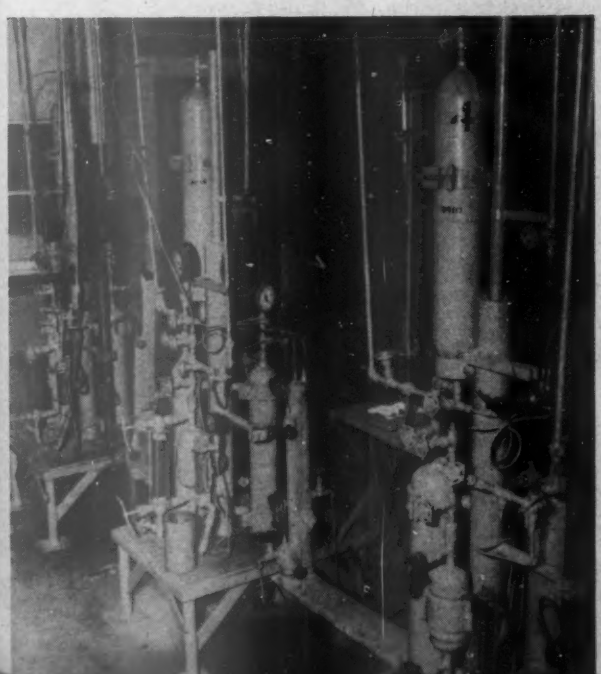
The product stream leaving the reactors is a mixture of normal and isobutane, anhydrous hydrogen chloride and traces of aluminum chloride. This is delivered to fractionation equipment as a pure hydrocarbon mixture by passing it through a bauxite-filled guard tower, hydrogen chloride stripper and a caustic wash system.

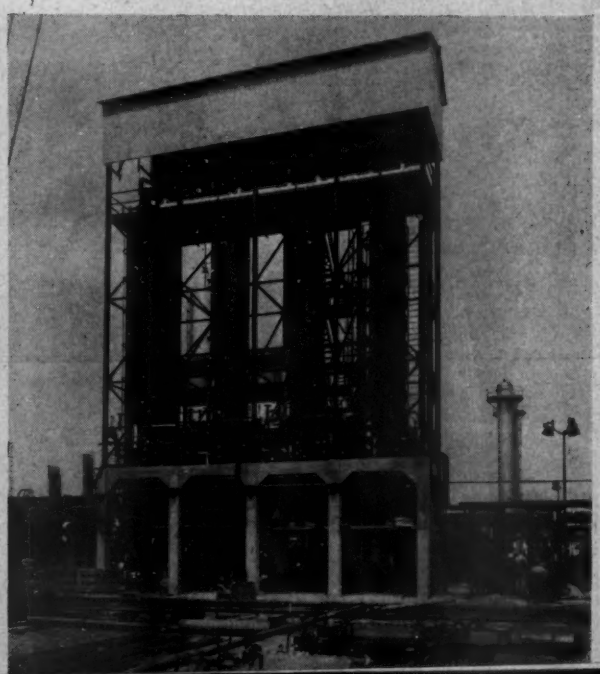
The bauxite adsorbent used in guard section duty must be specially prepared to give maximum aluminum chloride adsorptivity and minimum water content to avoid corrosion trouble. As bauxite is an excellent desiccant, it has been found desirable to dry the material in the guard chamber with hot gas to drive off adsorbed water. The iron content of the bauxite must also be low to minimize reaction with hydrogen chloride, which reaction would generate water.

The vapor-phase isomerization process employing in situ impregnation of the bauxite support, counteracts the slow desorption of aluminum chloride and subsequent loss of conversion activity by further intermittent injection of fresh aluminum chloride from vaporizing vessels adjacent to the feed stream outside of the reactors. Throughout the relatively long life of the reactor charge the upper portion of the highly adsorptive bauxite support acts as a guard against carryover, from the reactor, of aluminum chloride and of undesirable reaction products. As an added insurance against final product contamination, separate bauxite guard towers have been used.

The operation of vapor-phase plants is characterized by relative freedom

Fig. 4 (Left): Butane isomerization units used in Isocel evaluation, in the laboratory. Fig. 6 (Right): Butane isomerization plant (Shell vapor phase) of Tide Water Associated Oil Co., at Avon, Calif.





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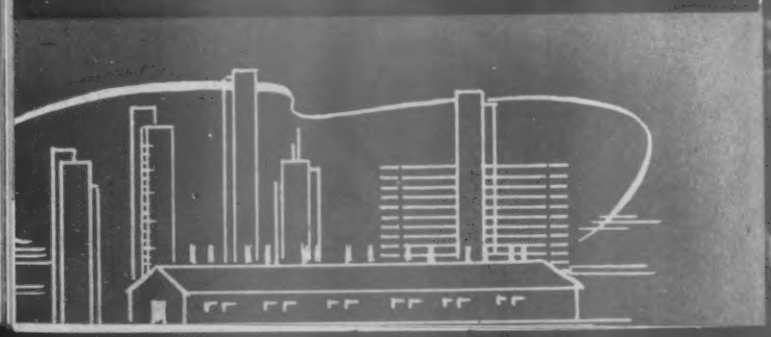

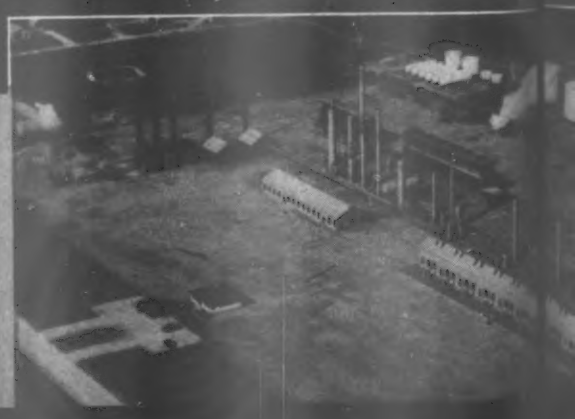

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"Good Old Number 1", shown at left, has been the prize performer in this battery of CLARK "Angles" at the La Gloria Corporation recycling plant, Falfurrias, Texas. It is undoubtedly the world's champion compressor unit for continuous operation. Number 1 was shut down, in the year 1942, due to engine fault or repairs, exactly 70 minutes . . . has shown comparable performance throughout the two and a half years it has now been in operation. A year contains 525,600 minutes. 70 minutes is less than 1/100th of 1% of the total.

But this entire battery of 11 8-cylinder, 800 horsepower "Angles" were only shut down an average of 8 hours each, during 1942, due to engine fault or repairs. That was only 1/10th of 1% of the total time and is undoubtedly another world's record.

CLARK perfected 2-cycle design explains the amazing record of these engines.

Economy of lubricating oil consumption has been equally amazing. This battery started operation in May, 1941. In two and one-half years, oil has been changed in only one engine. The cause was a bad piston. There was no sign of sludge in the oil, and crankcase walls were clean.

Call on CLARK engineers for the whole story of CLARK "Angle" performance.

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from corrosive problems usually present in catalytic processes employing aluminum chloride. This avoids the necessity for special corrosion-resistant construction materials, contributing the advantages of low first cost and low maintenance expense. The readily available catalyst materials and comparative freedom from equipment failures permit uninterrupted periods of extended operation which are directly reflected in low production costs.

The urgency of the demand for isobutane which has existed since the inauguration of the program for supplying high-octane aviation fuel in the required quantities, coupled with the inability of some refiners to obtain the correct feed stocks for their isomerization plants, has in some instances prevented a full realization of the potential economies of vapor-phase isomerization. Any postwar evaluation of vapor-phase isomerization should not be based on wartime operations, since the vital need for maximum production at whatever cost has forced discard of catalyst above normal economic levels and disregard, in the n-butane feed, of impurities deleterious to catalyst performance.

Bauxite in Catalytic Alkylation

Because of the importance of alkylation in the 100-octane-gasoline program, the refining industry has become generally familiar with the various processes for catalytic alkylation. The subject will, therefore, require little introduction here. Originally carried out by applying certain elevated thermal and pressure conditions, the commercialization of the reaction received great impetus when it was shown that concentrated sulfuric acid could perform the function of a catalyst for the uniting of olefins and paraffins, particularly isoparaffins, and many large-scale units operating with sulfuric acid are in use. On the other hand, a large proportion of more recent plants have been based on the use of anhydrous hydrogen fluoride as the catalyst.

Since anhydrous hydrogen fluoride is quite low in corrosive action on steel, this reagent can be employed without resort to acid-resisting equipment. However, water solutions of hydrogen fluoride corrode steel rapidly, hence it becomes very important to drastically limit the percentage of water which gains entrance to hydrogen fluoride alkylation plants. Moreover, it has been stated that the hydrogen fluoride losses in such plants are proportional to the quantity of water getting into the unit (excluding leaks and spillage), which is an added reason for minimizing water allowed to enter.

Therefore, before fresh liquid feed is pumped to the reaction vessels, it is thoroughly dried by means of adsorbent drying units. From the above, the importance of this step may be appreciated, and it can be said that this method has proved well suited to the need and is reliable in practice. The drying units themselves are similar to those described under drying of gases and liquefied hydrocarbons with bauxite.

Simultaneously with the main reaction producing alkylate, some organic fluorides are produced and small quantities of these would be found in the alkylate, the propane, and the butane removed from the units unless precautions are taken. Obviously fluorides are very unwelcome in these products.

While most adsorbents exhibit some ability to remove these fluorides, a specific grade of activated bauxite has provided the means for eliminating these compounds on a commercial scale. Usually two towers packed with granular bauxite are employed to operate on the entire reaction effluent following removal of hydrogen fluoride. In this service, bauxite removes the fluorides almost quantitatively until from 15 to 40 per cent by weight, based on bauxite, is retained by the bed. Because no means of regenerating the bauxite in this service is at present practicable, relatively large beds are employed to provide long operating cycles between changes of the adsorbent. Traces of fluorides which may be found in the alkylate stream following these main defluorinators are picked up by a second set of much smaller bauxite towers placed immediately ahead of the alkylate rerun unit.

In the past, removal of dissolved water in feeds to sulfuric acid alkylation plants has apparently received relatively little serious attention, although disposal of the reject acid is frequently troublesome. In general this acid has found utility in other industrial processes. Frequently other refinery operations, notably lubricating oil, gasoline or kerosene treating, will use it, although not always without some sacrifice in these operations. Consequently, the alkylation plant usually receives a fairly substantial credit for the rejected acid.

There appears to be a situation in the making which may aggravate the spent-acid problem, at least in individual instances. It has been reported in the press that before the year is over the demand for concentrated acid will exceed the total planned production. Moreover, it may be surmised that the supply of spent alkylation acid will exceed its available uses, particularly when all plants, including those which remain to be put into operation, are running at maximum capacity.

It is equally obvious that feed stocks can be dried in the same manner as in the case of hydrogen fluoride alkylation feeds, thus extending the useful life of the acid in the unit; and since the quantity of critical materials and cost of drying installations are relatively small, interest in this direction appears to be increasing. In at least one instance, it has been noted that such a drier is to be installed. It may be calculated that acid saved would be of the order of 5 per cent of fresh acid makeup, which by itself may only be important if a majority of plants effect this saving. However, aside from the consideration of reducing the rate of water dilution of the acid by eliminating dissolved water in the feed stocks, some other advantages may result, including improvement in octane values and yields of the alkylates and reduction of unwanted side reactions which themselves probably split out water.

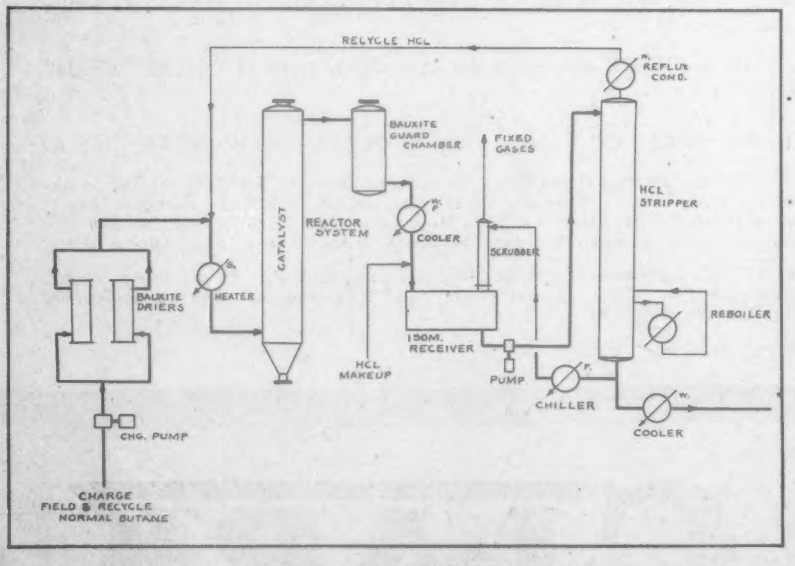

Fig. 5: Isomerization of n-butane

A LOOK AHEAD—To the Future Of Instrumentation in Refining

*by K. B. Knoblauch**

WAR has quickened progress. In a thousand laboratories, in a thousand places, exciting inventions are taking place. Just as our past has prepared us for the present, so is our present preparing us for the future. War has unlocked inventive genius to give us a more abundant life when strife ceases.

Petroleum industries are assured of a great future beyond victory because of vision, because we are anticipating the golden age ahead—a time more potentially rich and productive than any the world has ever known . . . a new age in instrumentation and hence petroleum products.

In the last 2 years the public press has written column after column on a huge and remarkable group of activities known as "100 octane" and "synthetic rubber." The more technical trade papers and scientific journals have been filled with such expressions as cumene, styrene, copolymer, butadiene, petro-chemistry, iso-this and iso-that. It is evident a far-reaching change is taking place in the petroleum industry.

Wartime refinery construction has greatly accelerated instrumentation of many processes which were little beyond the pilot-plant stage at the beginning of the war; i.e. isomerization, fluid catalytic cracking, hydrogen-fluoride alkylation; butadiene, toluene and ethyl alcohol extraction. These processes have presented a variety of somewhat new instrumentation problems, although many of them have resulted in applying modern instrumentation to relatively old problems, in effect, crowding a decade of technological advance into a few months' time.

Just why is it we can produce laboratory curiosities of yesterday in unbelievable quantities today?

The answer, categorically speaking, is simple: Today we have tools for doing it; yesterday we did not.

It is not the intent of this article to identify the number nor importance of the tools utilized to achieve these results. It is our aim to show how a group of tools known as industrial measuring and controlling instruments were vital to these advances; how they are well on the way to meet tomorrow's problems. In a surprising number of cases they have already arrived.

Instrument-control panel board, showing air-operated potentiometer recording controller and recording multivoltmeter pyrometers at Anderson-Prichard Oil Co., Cyril, Okla.

Temperature Measurement

Without temperature measurement of the proper kind, for instance, even a still of 20 years ago could not have been operated. The requirements today are amazingly more difficult and complex; tomorrow's will be even more so. Some of tomorrow's temperature problems have been anticipated and many things already accomplished.

Undeniably, the thermocouple has come into its own as the most all-around accurate, sensitive, and reliable principle for measuring temperature. Tube systems have their place and properly so, but when it comes down to borderline activities where advantages must be taken of every possibility, there is yet to be found any primary measuring source which will even approach the thermocouple.

During this war period, we have learned how to design thermocouples to respond far more rapidly than the process itself. Without this primary speed, all improvements in instrumentation would avail little. Yesterday's temperature lags were expressed in terms of minutes, now they are spoken of in seconds.

But thermocouple responsiveness is not in itself the entire story. In order to take advantage of this characteristic, instrument responsiveness has recently been increased. The combination of these is something hereto-

Knoblauch has been with the Brown Instrument Co. for the past 20 years. He is a graduate chemical engineer, University of Pennsylvania, a Sigma Xi and a Tau Beta Pi. In his present connections he has served in the engineering and field sales divisions of the Brown company. Knoblauch holds three patents on control systems.

*Petroleum manager, The Brown Instrument Co.

fore unknown to the petroleum or any other industry. Yet, we are on the threshold of still greater speed possibilities.

In the modern refinery, there are hundreds of temperature points where recording and controlling instruments are not needed. In the past these have been indicated by a manually operated central reading indicator. The value of such a system was decidedly limited because the operator's hands were needed to bring the instruments into balance. Today's indicator will bring in readings at the rate of about 2 seconds per point. Because the instrument balances automatically, the operator's hands are left free for writing. Just as soon as the petroleum industry is able to use it, the speed can be increased to 1 second per point. This is not a prediction. The instrument has already been built and is in service in other industries.

Lead Lengths Unimportant

It is unaffected by long-lead lengths. Number 16 gage lead wire is recommended even though WPB's L-134 has made Number 14 gage again available, presumably due to sensitivity limitations of conventional mechanical potentiometers.

Precision goes hand in hand with speed. Accuracy of these central reading potentiometer indicators is ⅛ of 1 per cent and sensitivity is 6 parts in 10,000. Such movements, of course, are undetectable to the naked eye on the 28-in. scale normally used.

Recording instruments have kept pace with the speed and precision of the indicator. When the petroleum industry is in a position to use it, a recorder making full-scale pen travel in 1½ seconds will be forthcoming, not as an experimental model, but as a tried and proven design. Several hundred of these instruments, known today as "flight test recorders" have logged thousands of operational hours, supplied clues for eliminating design defects in airplane engines and air frames, under flight conditions where a human being was not physiologically able to sense and log readings.

Unqualifiedly, however, the most powerful tool comes to the refiner when this high-precision electronic potentiometer is linked to an air-actuated control system. Many things are possible through its use which were hitherto almost inconceivable. Comparative tests in the petroleum industry have indisputably shown this high-sensitivity measuring circuit, tied in with continuous balance and consequent instantaneous positioning of the air-control flapper, is the answer to tomorrow's requirements. Any conclusions regarding temperature control should not be considered complete or final without recognizing this combination. Evidence accumulated on hundreds of cases bears dramatic confirmation to this statement.

Because of the continuous balancing action of the electronic air-control potentiometer, limitations inherent in the mechanical or nudging type of potentiometer are completely eliminated. This means the controlled air pressure is continually responding to every small change. The introduction of a high capacity nonbleed pilot, another wartime innovation, means instantaneous valve response, reduction of "flywheel cycling" and brings about hairline control on otherwise ticklish jobs.

Installations now in service have shown that many poor control installations formerly attributed to process lag were actually due largely to lack of precision in the measuring circuit and to laziness or dead spots in the pilot system. Such practices as over-correction find their greatest value in overcoming measurement and pilot-system crudeness and find proper application in only a very small per cent of cases. With proper measuring and pilot sensitivity, there is seldom need for anything but throttling range adjustment and reset in control instruments.

Tomorrow the full scale span in degrees will be considerably smaller than it is even today. There is a good possibility this electronic potentiometer may operate on full-scale temperature span of 20° F. Today, changes are small as 1/10 of 1° are reflected in the controlled air pressure, and hence in the controlled valve. Tomorrow even greater control sensitivity will be available. The technique of pure-product separation will receive enormous stimulation.

Research Department Tool

Whereas, up to this point chief concern has been with the operating department, research departments have found amazing value in the electronic-potentiometer possibilities. As mentioned, the precision self-balancing indicator is direct reading, eliminates manual balancing, conserves manpower, has no galvanometer and is unaffected by vibrations and external resistance which decidedly handicap mechanical potentiometers. In the laboratory, as well as in the refinery, sensitivity of the electronic potentiometer is maintained even when the external resistance amounts to several hundred ohms. Typical laboratory applications for the precision indicator include routine temperature and millivolt measurement, engine testing, knock engines, low and high-temperature - distillation apparatus, furnace and oven temperatures and millivolt output of pH.

Temperature measurement and control is sometimes treated as the pampered darling of refinery instrument problems. Due credit should be given the work horse of the refinery-instrument family, the differential-flow meter. Many times the successful operation of a ticklish temperature application can be traced to the help given it by the flow controller with its steady, balance-wheel regulation of inputs, drawoffs, etc.

There have been two broad developments in the flow field during the past 2 years. The more recent of these has arisen because refineries are becoming more and more chemical plants requiring the use of acids, molten salts, etc. In particular, HF is being widely used and one of the problems which had to be solved quickly and satisfactorily was the design of a meter to measure or to control the level of fluids where this corrosive element was present. It was evident at the beginning that such things as pressure-tight bearings, thin-walled bellows, etc., were at an inherent disadvantage and that any design approaching bottle-tight construction as an ideal would be the proper one to develop. Fortunately, inductance-bridge transmission permitting magnetic transfer of position from inside to outside of a pressure vessel was well known and it simply became a matter of starting from that point and doing the things necessary for the specific problem at hand.

Upside Down Meterbody

Solution proved to be simple. The float and its attachment were turned upside down and submerged in the mercury. Now the same mercury which fills the U-tube also seals the float. Just as the name "jeep" is derived from practical usage, this meterbody has become known as the "upside down meterbody."

Put a steam-heated jacket around this same meterbody, pipe it close to a line carrying molten salt and the result is a means of measuring molten-salt flows.

Conversely, run cold brine through the jacket, make the piping self-venting and a meter results which cannot become vapor locked. Since no pressure-tight bearing is used, the problem of finding a grease capable of withstanding the solvent action of propane and similar hydrocarbons becomes nonexistent.

There are many other detailed facts which could be presented to indicate that the industrial instrument industry has shown itself capable of not only keeping up with the times and meeting the manifold problems tossed to it, but is actually leading the parade and making possible even greater technological improvements in the industries it serves. There are hush-hush ideas in research laboratories which cannot be made public. Tomorrow they will be commercial practice and the petroleum industry can be assured that, when the time comes, the instrument industry will be on hand with the tools needed for what is required.

Mechanical Shaft Seal For Centrifugal Pumps

by George V. Shaw*

THE development of our extensive petroleum pipe-line systems and the great expansion and improvements in our refinery processes have been possible largely because of the ability of our equipment manufacturers to keep pace with the progress made by our petroleum engineers.

Everyone is familiar with the conspicuous part played by the centrifugal pump in these great developments. These are now largely used in pipe-line service and for practically every pumping duty in the process industries, where liquids are moved in transportation and manufacturing cycles. Centrifugal pumps have been developed and built along with the processes in which they serve and designs have been refined to meet the most exacting requirements.

Light liquids, high pressures and speeds have necessitated the development of a more reliable and economical means of sealing a rotating shaft than can be obtained when using the conventional stuffing box and packing. Pump engineers and manufacturers have recognized this problem and long and serious research has been applied to the solution of it.

For instance, the Cameron shaft seal, developed by engineers of Ingersoll-Rand Co., is based on more than 15 years of field experience, persistent shop research, and experimentation. This seal provides by mechanical means a simple and effective method of sealing centrifugal pump shafts, when these shafts operate under conditions where conventional packing would be expensive and troublesome. One type of Cameron mechanical seal was put in service on main pipe-line pumps in 1928 and a number of these original seals are still in service.

Now, new and improved single and double seals are available for use on Ingersoll-Rand Cameron pumps. The choice of type depends on the service conditions. However, in order not to complicate the description, this discussion will deal primarily with the single seal which is applied on most services, unless the liquid handled by the pump is corrosive.

The sealing element consists of a rotating and stationary member, having sealing faces that are brought into sliding contact under a pressure sufficient to prevent the escape of liquid. These seal members are rings that are substantially mounted about a shaft sleeve, with a sealing face on one side of each ring. The surface opposite the sealing face is seated on a ring of packing. The stationary seal ring packing is seated against the outer gland, while the rotating seal ring or telescopic sleeve is fitted with cup-shaped packing that seats on the shaft sleeve and is firmly held in position by a spacing collar. The packing seats allow sufficient movement so that the seal faces maintain perfect contact and alignment. The contact pressure between the sealing faces is low, so that there is little wear. Spring force is provided for keeping the seal faces together when the stuffing box is not under operating pressure. Small coil springs supplying the pressure for this purpose are spaced around the shaft and properly guided to assure an even loading.

The entire rotating element of the seal is mounted on a shaft sleeve before it is assembled into the pump, so that no adjustments are necessary once the seal is in place.

An important feature of the design of the Cameron shaft seal is that it will operate in liquids that possess poor lubricating qualities. The seal is in partial hydraulic balance and the unit contact pressure between the sealing faces can be controlled. As designed, the unit contact pressures are relatively low so application to service where the liquid has poor lubricating qualities or the pressures on the seal are high is feasible.

On pump installations where high-gravity, light hydrocarbons are handled, the Cameron shaft seal is provided with auxiliary packing and provision is made to vent any gases escaping through the seal either to atmosphere or to the gas line.

Low contact pressures on the sealing faces may be more readily understood by the illustration, Fig. 1. The pressure within the stuffing box will act over area "A" and the resulting force will bring the faces of the telescopic sleeve and the seal ring in contact under a certain pressure which can be controlled and adjusted to the operating conditions by changing the contact area "B."

The statements concerning the design of the single seal are applicable to the double seal. This latter type consists of two single seals mounted on the same shaft sleeve but operating at opposite ends of the stuffing box. This arrangement of the seal is generally used for conditions involving corrosive liquids, such as acids in alkylation and isomerization plants, where it is desirable to keep the liquid from coming into contact with the seal parts. To accomplish this, it is necessary to inject oil or other suitable liquids between the two seals at a pressure differential of approximately 10 lb. above the pressure on the stuffing box. The liquid from between the seals being under higher pressure than the liquid inside the pump at the stuffing box, will tend to seep to the inside of the pump, thus keeping the corrosive fluid from contacting the seal parts. To provide sealing medium injection, it is necessary to have additional equipment.

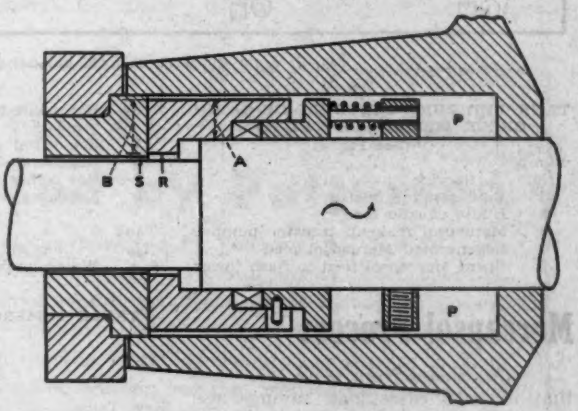

Fig. 1: Drawing showing the essential design details of the Cameron shaft seal

Certain outstanding advantages of the Cameron shaft seal over packing are apparent:

1. Once installed, it requires no further adjustment.
2. Low contact pressure between sealing faces allows of its use for high stuffing-box pressures and for liquids having poor lubricating qualities.
3. It is suitable for shaft sealing pumps having variable loads or stuffing-box pressures.
4. No outside lubrication is needed where the service permits the use of a single seal.

*Ingersoll-Rand Co.

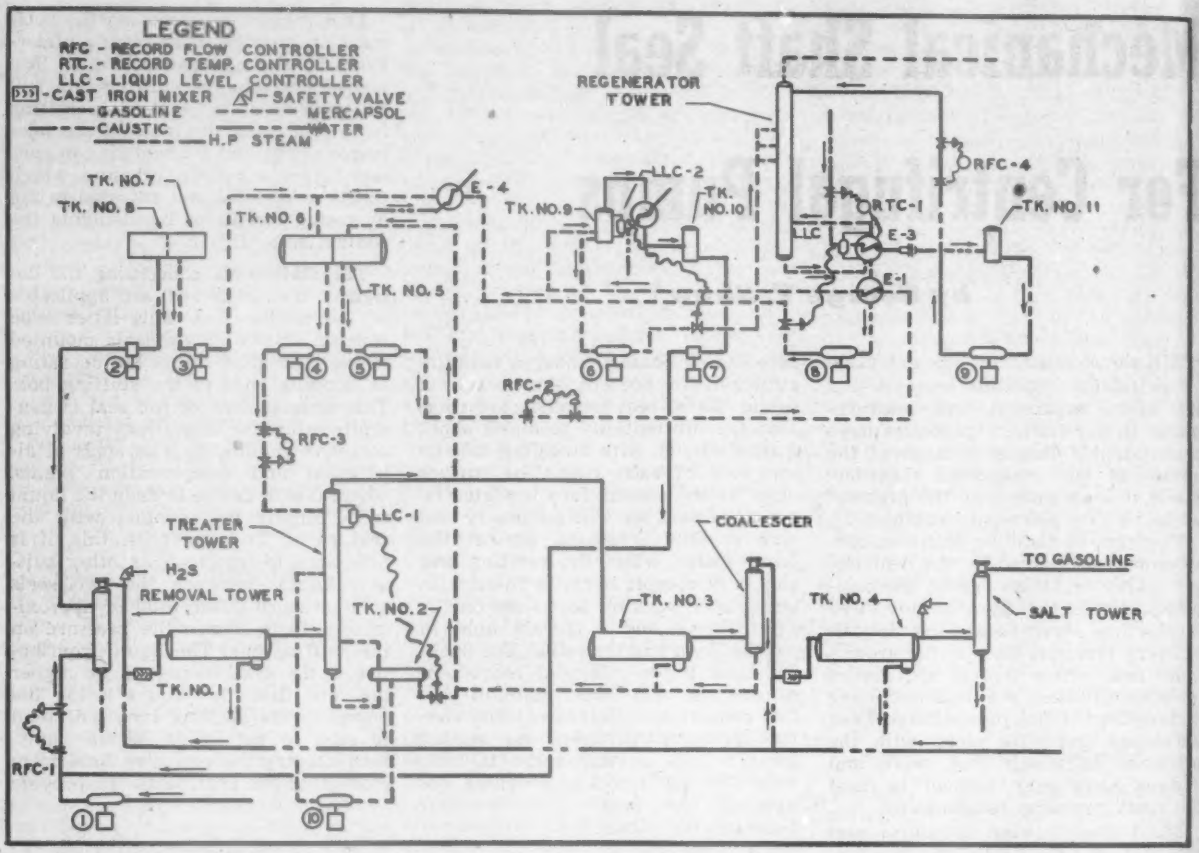

Fig. 3: Flow diagram of 5,000-bbl.-per-day Mercapsol treater at Cabin Creek, W. Va.

TANK AND PUMP SCHEDULE OF CABIN CREEK MERCAPSOL TREATER
(See Fig. 3)

Pump No.	Service
1	Raw gasoline feed
2	Dilute caustic feed
3	Mercapsol makeup transfer pump
4	Regenerated Mercapsol feed
5	Spent Mercapsol feed to flash tower
6	Hot spent Mercapsol to regenerator tower
7	Recovered gasoline return pump
8	Regenerated Mercapsol to storage
9	Hot reflux water
10	Mercapsol circulating pump

Tank No.	Service
1, 4	Water wash settler
2	Mercapsol gasoline settler
3	Mercapsol settler
5	Regenerated Mercapsol storage
6	Spent Mercapsol storage
7	Mercapsol makeup
8	Dilute caustic makeup
9	Gasoline flash tank
10	Recovered gasoline accumulator
11	Hot water reflux tank

Mercapsol Process

(Continued from page 127)

that in both cases lead savings are appreciable over the raw gasolines, which indicates even greater savings over the doctor sweetened gasolines where lead depreciation is almost invariably encountered.

Table 2 shows data from the 5,000-bbl. Mercapsol treater on two gasolines, a Pennsylvania straightrun and a thermally cracked gasoline from Pennsylvania and Mid-Continent mixed gas oils. Although the mercaptan sulfur of the raw gasolines is low, slight octane appreciation is shown for both clear and leaded samples, and the net saving in TEL compared to the doctor sweetening process which this Mercapsol treater replaced has proven substantial.

Conclusion

The doctor test is obsolescent in the petroleum industry, and as far as motor fuels are concerned there are definite indications that it will soon cease to exist. For this reason the Mercapsol treating process, while capable of producing doctor sweet gasoline by using a moderately high treating ratio, is more economically operated by designing for a minimum treat consistent with acceptable odor. The 5,000-bbl. unit described previously was designed for 7 per cent of Mercapsol solution based on 100 per cent gasoline throughput. In the 3 years of operation no single odor complaint has been registered, although millions of gallons of gasoline sour to a strict-

TABLE 1—MERCAPSOL TREATED CRACKED GASOLINES FROM PILOT PLANT

	Per cent treat	Weight, per cent RSH-S in gasoline	Per cent RSH-S removal	Total sulfur
Raw Talco	....	0.091	....	0.27
Treated Talco	6.7	0.0025	97.2	0.16
Raw Mid-Continent	....	0.042	....	0.07
Treated Mid-Continent	3.0	0.0068	83.8	0.04

OCTANE NUMBERS AND LEAD SUSCEPTIBILITIES
(See Figs. 4 and 5)

Cubic centimeters, TEL per gal.—	0		0.5		1.0		2.0		3.0	
	MM*	Res.	MM	Res.	MM	Res.	MM	Res.	MM	Res.
Raw Talco	69.2	75.4	70.9	78.8	72.0	80.6	73.8	83.5	75.2	85.2
Treated Talco	69.6	75.2	72.2	79.2	73.8	81.8	75.8	85.4	77.7	87.7
Raw Mid-Continent	63.9	68.4	68.7	73.4	70.6	76.7	74.2	80.3	76.8	82.2
Treated Mid-Continent	64.2	68.6	69.0	73.8	71.5	77.6	76.0	81.6	78.1	83.9

*MM—A.S.T.M. motor method octane number. Res.—1939 research octane number.

ly interpreted doctor test have been marketed.

The advantages of the Mercapsol process for gasoline treating may be summarized as follows:

1. Mercaptans are almost completely removed in one treating operation.

2. A low treating ratio is used, resulting in economical utility requirements for regeneration of the solution.

3. The solution itself is cheap and is usually readily available. It is not exhausted by repeated use but may be regenerated indefinitely.

4. The operation is simple and with adequate instrumentation requires a minimum of attention.

5. The operating conditions are mild and no expensive alloys are required nor is corrosion encountered.

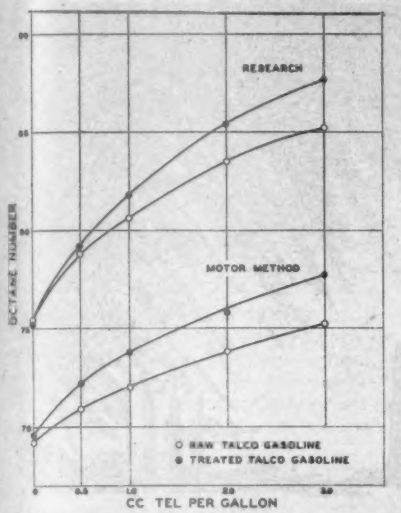

Fig. 5: Lead-susceptibility curves for raw and Mercapsol-treated thermally cracked gasoline from Talco crude

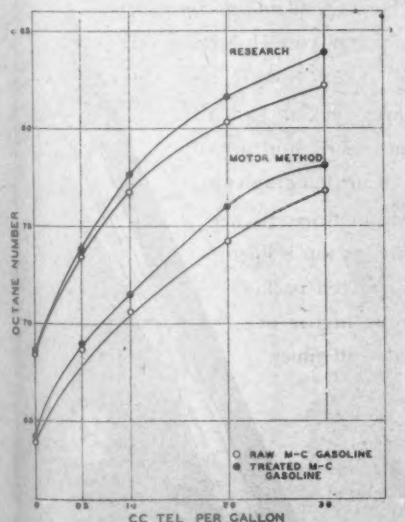

Fig. 4: Lead-susceptibility curves for raw and Mercapsol-treated Mid-Continent C.H.P. gasoline

TABLE 2—MERCAPSOL TREATED GASOLINES
(From 5,000-Bbl.-Per-Day Unit)

	Per cent treat	Weight, per cent RSH-S in gasoline	Per cent RSH-S removal	Total sulfur
Raw Pennsylvania straightrun	....	0.0089		0.019
Treated Pennsylvania straightrun	3.1	0.0020	77	0.009
Raw cracked gasoline	....	0.0142		0.034
Treated cracked gasoline	3.0	0.0010	93	0.021

OCTANE NUMBERS

Cubic centimeters, TEL per gal.—	0		1.5	
	MM	Res.	MM	Res.
Raw Pennsylvania straightrun	55.2	53.1	66.4	67.3
Treated Pennsylvania straightrun	55.6	53.3	68.0	67.9
Raw cracked gasoline	62.9	64.9	72.7	77.0
Treated cracked gasoline	63.2	65.1	73.2	77.1

6. Existing equipment can be fully utilized in converting a doctor or caustic washing plant to the Mercapsol process, and capital expenditure is held to a minimum.

7. The solution is not more toxic nor more dangerous to handle than caustic soda solution.

The pilot Mercapsol unit herein described is located at the Northfield, Ill., laboratory of The Pure Oil Co., and is available for experimental gasoline treating.

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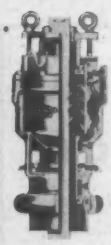

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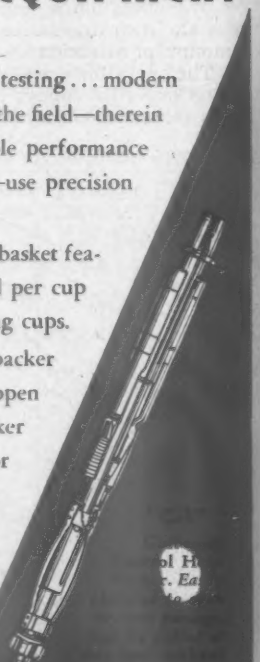

THE GUIBERSON CORP.

Pneumatic-Set Controller Gives Automatic Process Adjustment

A NEW member has been added recently by Taylor Instrument Companies to the Fulscope family—the pneumatic set controller. Designed for use in two-instrument control systems where a temperature, pressure, rate of flow, or liquid level is required to conform to changes in another variable related to the same process, the instrument has these features:

1. Control point is indicated by a set pointer and adjusted by variations in input air pressure coming from another instrument and resulting from changes in some other variable, either controlled or uncontrolled.

2. Visible control point adjustment provides a continual check on the quality of control in effect.

3. An adjusting dial which is calibrated in "inches of set pointer movement per pound change in input air pressure," determines the magnitude of linear set pointer travel.

4. Set pointer always indicates the correct control point, regardless of the ratio in which the instrument is set.

5. Set pointer movement is reversible. Full-range continuous ratio adjustments can be either direct or inverse for an increase in input air pressure.

6. Control-point setting can be manual, allowing process to be started under full manual control and gradually changed over to full automatic.

7. With ratios less than 1 to 1, the pneumatic set control band can be positioned for any desired section of the chart or scale.

8. High and low set pointer travel limits can be established by means of stops which are standard in the pneumatic adjustment unit.

9. This pneumatic set controller is available with any of the standard types of Fulscope control which are, fixed high sensitivity, adjustable sensitivity, adjustable sensitivity with automatic reset, adjustable sensitivity with preact, and adjustable sensitivity with automatic reset and preact.

Typical Uses in the Petroleum Industry

Pneumatic set control is already well established in the petroleum industry in the control of such applications as:

Fractionating towers. — The transmitter is a liquid-level instrument on the tower, adjusting the set pointer of the pneumatic set instrument, located adjacently or remotely, which controls the flow from the tower.

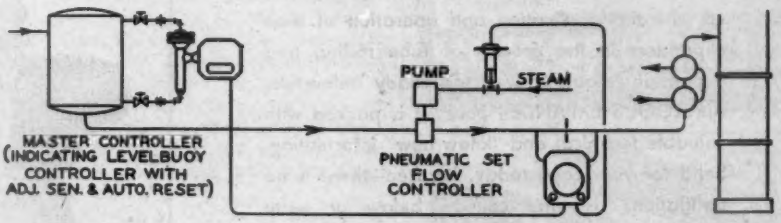

Fig. 2

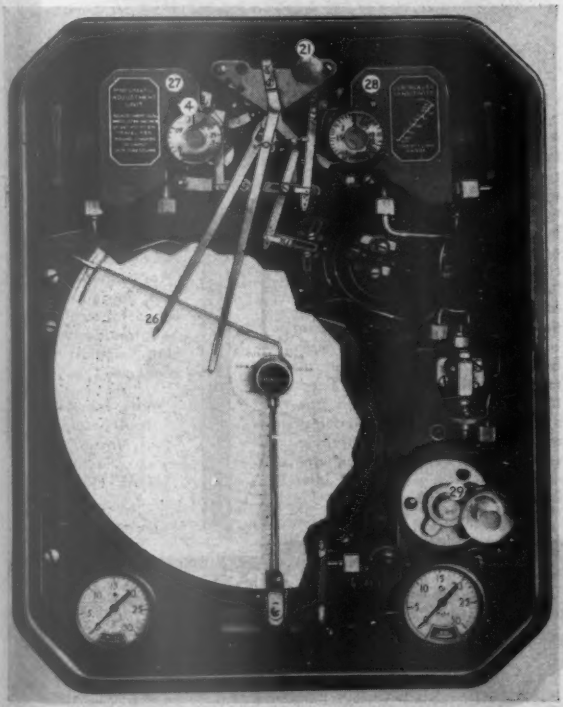

Fig. 1: Taylor pneumatic set controller equipped with adjustable sensitivity (28) and automatic reset (29). The pneumatic adjustment unit (27), is linked to Fulscope control mechanism. Ratio adjustments are effected by a transparent knob (4) located in front of a dial calibrated in inches of set pointer (26) movement per pound change in input air pressure. Manual-set point adjustments are made through the use of knob (21). For schematic drawing and description of operation, see Fig. 4

Reboiler outlet temperature control.—The outlet temperature instrument adjusts the set pointer of the pneumatic set flow controller which then increases or decreases the steam or hot oil flow to the reboiler.

Pipe-still outlet temperature control.—Here the transmitter measures the outlet temperature and resets the control point of the pneumatic set controller which regulates the fuel supply to the burners.

The versatility of pneumatic set control is indicated by the following schematic drawings. In Fig. 2, the problem is one of maintaining a nearly constant withdrawal of liquid without permitting tank level to vary excessively. The transmitting level instrument, equipped with adjustable sensitivity and automatic reset, is set in low sensitivity and with a slow reset rate. Ordinarily this instrument could operate the control valve directly except for the fact that variations in steam pressure, pumping head, downstream pressure, or a partial plugging of the valve would produce undesirable variations in the flow rate. Instead, the output air pressure of the transmitter sets the con-

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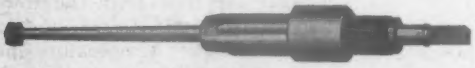

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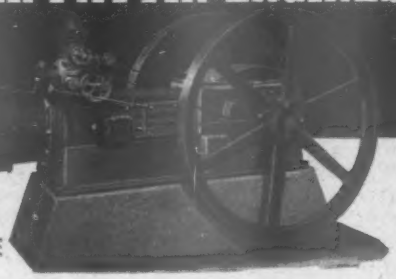

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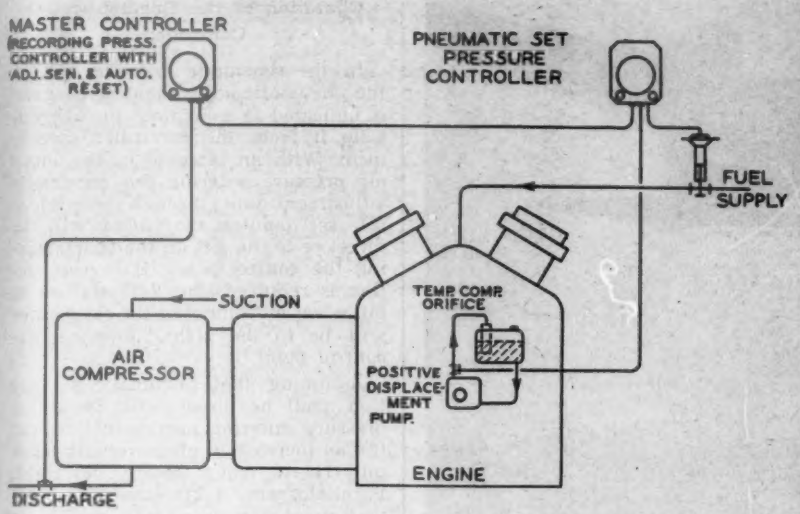

Fig. 3

trol point of the pneumatic set controller which regulates the steam valve. Thus a required flow is maintained in spite of load changes at any point in the system.

For another example of the simplification by pneumatic set of an otherwise complex control problem, refer to Fig. 3 representing an industrial air compressor, powered by an internal-combustion engine. Air-delivery demands on such compressors generally vary suddenly and widely and require comparable changes in fuel-throttle valve position if constant output pressures are to be maintained. Such a system is practically uncontrollable without pneumatic set, because of flywheel inertia effects.

With the addition of pneumatic set to the system, the transmitting instrument, instead of adjusting the engine throttle, calls on the pneumatic set controller for an engine speed exactly correct for the maintenance of required discharge pressures. The limit stops of the pneumatic adjustment unit prevent the engine from going out of bounds and also from stalling.

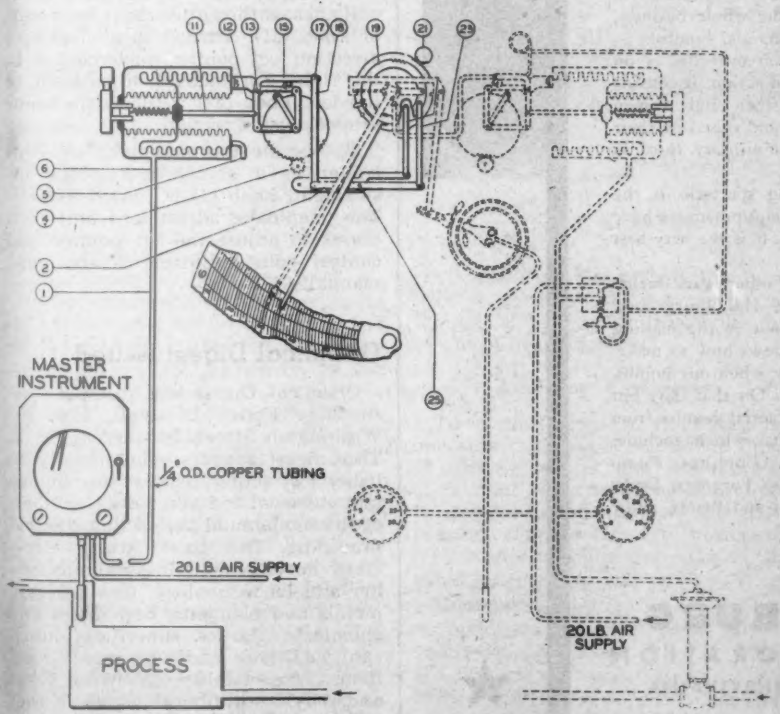

Fig. 4

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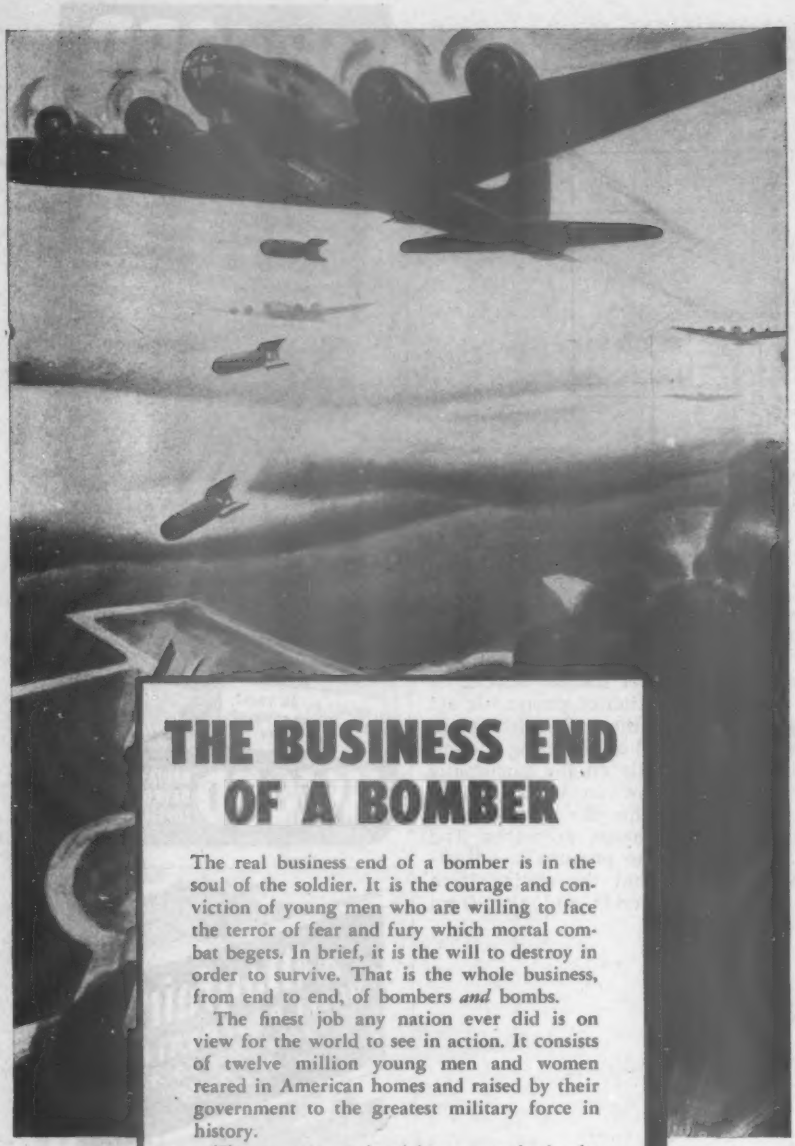

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Operation of the Pneumatic Set Controller

In the schematic drawing Fig. 4, the pneumatic adjustment mechanism is indicated in solid lines to differentiate it from the controller mechanism. With an increase in the input air pressure entering the pneumatic adjustment unit through line (1) at (6), set pointer movement will be direct or to the left on the chart, raising the control point. If inverse action is required, line (1) attaches at (5), when movement of the set pointer will be to the right, lowering the control point.

Assuming that pneumatic set action shall be direct with input air pressure entering outside bellows at (6), an increase in pressure will cause pin (11) to move toward the right. Parallelogram (12) transmits this movement to arm (15) which is pivoted at (13), moving it upward. The resulting upward movement of pivot (17) is transmitted through link (18) to bell crank (2) which pivots at (25). Link (23) which attaches to floating gear (19), to which set pointer is attached, is drawn downward. Set pointer moves to the left.

The extent of set pointer travel, per pound change in input air pressure, is governed by ratio adjusting knob (4). Travel increases as knob is turned to higher dial readings. The dial is calibrated in inches of set pointer movement per pound change in input air pressure, the units ranging from 0 to 0.4 in. per pound.

Set pointer may be adjusted manually across the entire chart by means of knob (21). Turned in a clockwise direction, set pointer movement is to the right. For manual adjustment to the left, knob (21) is turned in counterclockwise direction.

To operate the pneumatic set controller as a standard Fulscope instrument, knob (4) is turned to zero. The pneumatic adjustment unit then ceases to adjust the set pointer and control point adjustments are made manually.

Chemical Digest Issued

Chemical Digest has just been issued by Foster D. Snell, Inc., 305 Washington Street, Brooklyn 1, N. Y. This digest appears semiannually in lists, abstracting briefly the important chemical and allied developments of the semiannual period immediately preceding. This issue stresses especially developments in synthetic rubber and its technology, uses for rare metals and elements, new drugs and chemicals, plastics, superfuels, lubricant additives and numerous other items. Also, a folder on "Who, What and Why?" outlining the work of that organization is available for the asking.

Propane Refrigeration

(Continued from page 129)

take by any combination of compressor cylinders in operation simultaneously there will be negligible entrainment of liquid from the trap to the suction header. As a further safeguard a small steam coil is usually located in the bottom of the suction header to evaporate any propane carried over to this point.

Compressor Fuel

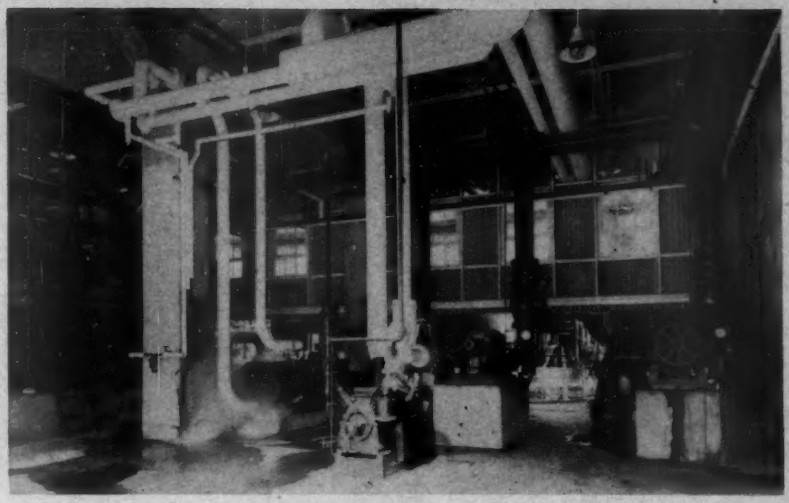
Consideration of available utilities within the refinery generally leads to the choice of gas-engine-driven single-stage compressors. Natural gas is the logical choice of fuel gas because of its low hydrogen-sulfide content. Refinery gas if used must be scrubbed for hydrogen-sulfide removal to meet the specifications of the compressor manufacturer.

To permit continuous operation of the equipment in the event of failure of natural gas or other fuel supply, it is desirable to make provision for the use of propane as fuel. Liquid propane in storage may be vaporized into the plant fuel-gas mains at small expense, and regulation of the compressors to use this fuel is easily achieved. In order to enable the speed governor on the engine to maintain proper control it is advantageous for the propane fuel to be regulated at a pressure about one-third of that normally used for natural gas. This is due to the greater heating value of propane. A capacity tank must be provided in the fuel-gas line to each engine and must have sufficient volume for the alternate operation.

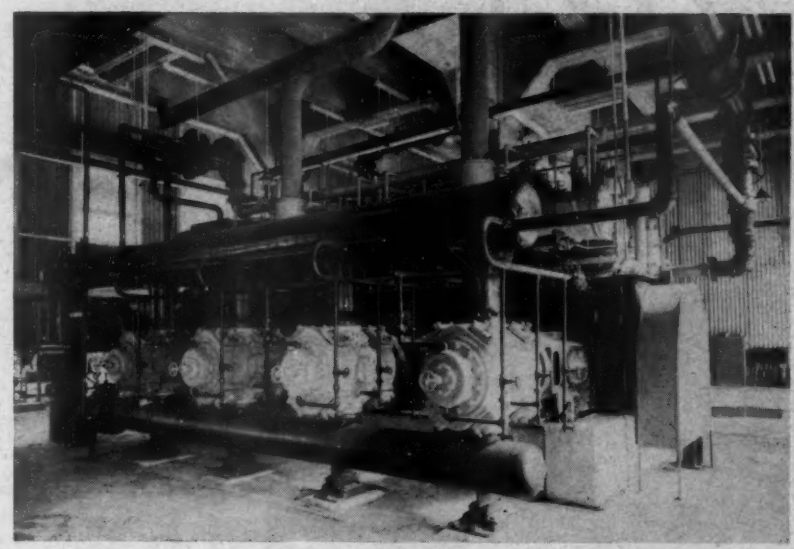
Protection Against Vibration

As is true for compressors in other services, it is necessary to take protective measures against excessive vibration particularly in installations of high horsepower. It has been found desirable to provide a total foundation mass at least five times larger than that of the machine. The foundations should be independent of the building foundations. The foundations of adjacent machines should be tied together. Foundations supported on piling should be augmented by the use of batter piles.

Special consideration should be given to the location and method of anchoring suction and discharge headers and lines. In refrigeration-unit installations it has been found desirable to locate the suction and discharge headers at or near ground level, outside of the building, supported by cradles. For the usual lengths of headers encountered, it is found desirable to firmly anchor the suction line at the point of inlet from the suction trap and the discharge header at the point of outlet to the condensers. Elsewhere along their length, the headers are tied down to the cradles by means of anchor bolts from lugs or yokes on the headers maintaining a tension on the bolts by means of heavy springs.



Building interior showing transfer pump, starting air compressor, jacket water pump and spare



View of the 1,000-hp. gas-engine-driven propane compressor

Auxiliary Equipment

To permit greater flexibility of operation and easier access at times of making repairs, the jacket-water circulating pump and spare pump are located independently of the compressors. The coolers for lubricating oil for the machines may also be located independently.

Numerous considerations enter into the operation and design of the jacket-water piping system, chief of which are the use of clean water to avoid fouling and a layout which will permit natural purging of occluded air in the circulated water. Steam condensate is used as makeup to the jacket-water system. The jacket water is normally used as a cooling medium for the lubricating oil, because the use of cold condenser water may permit cooling of the oil to temperatures below those recommended by the compressor manufacturer. In the jacket-water flow the cooler is normally located on the discharge of the pump and upstream of the connections to the compressor cylinders and engine jackets to avoid high head on the latter. While the accompanying flow diagram shows the lube oil cooler, compressor cylinders, engine jackets and so forth all in parallel in the jacket-water flow, the various compressor manufacturers will frequently recommend variations in this system, placing one or more of the items in series with another, depending

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upon the quantities and operating temperatures desired.

Air which is present in the system accumulates in the propane receiver. Elimination may be accomplished easily by bleeding continuously a small quantity of vapors from the receiver to a small vessel or pipe which is refrigerated by means of a small coil containing refrigerant evaporating at suction pressure, thus permitting condensation of propane from the vapors and the venting of noncondensables to the atmosphere. As shown in the accompanying schematic-flow diagram, this simple apparatus may be mounted on the top of the propane receiver.

Removal of Water

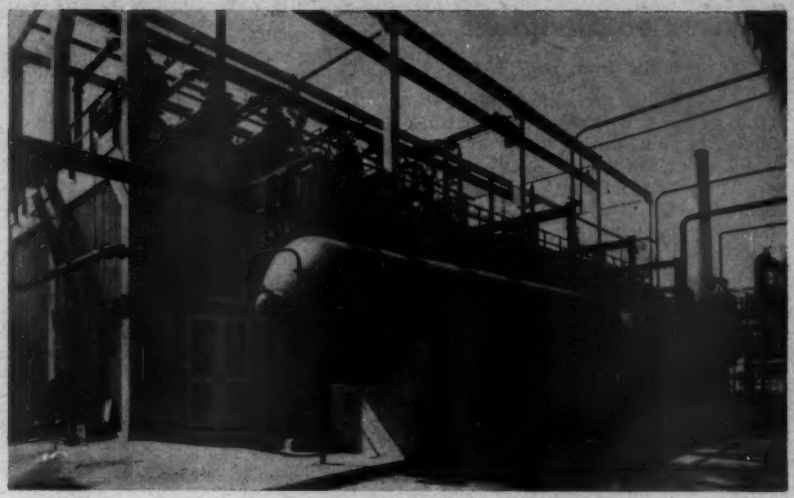
To remove residual water within the refrigeration unit and the small amount of water which is charged with the makeup propane a drier is found necessary for the best operation and maintenance of the equipment. For this purpose a small vessel filled with flake calcium chloride or unslaked lime is sufficient, providing the propane is then filtered by some means such as by passing through a sand bed.

The liquid refrigerant should be checked periodically for water content and, if water removal is deemed necessary, a batch of propane may be circulated from the propane receiver to the storage drum independent of the operation of the unit and at rates governed by capacity of the drier. This circulation is accomplished by venting the storage drum to the suction of the compressors. In general, this is more convenient than using the high capacity propane transfer pump throttled down to very slow speed.

Normally the manufacturers' recommendations should be followed regarding the quantities of lubricating oil fed to the compressors. It is necessary, however, at times to increase the amount of oil above recommendation of the manufacturer. This will frequently occur when the machines are new and are being broken in. As a result, difficulty is likely to arise from contamination of the propane refrigerant by the lubricating oil.

A fundamental prerequisite of the lubricating oil used is that it should be free of asphalt. Otherwise the propane will deasphalt the oil and allow asphalt to precipitate on the chiller tubes.

The use of baffled vessels or separators in the discharge of the propane compressors for oil removal has proven unsatisfactory probably because of the highly pulsating character of the flow and the fine dispersion of the oil in the hot-propane vapors. Propane contaminated with oil in the various chillers or reactors at the alkylation unit will cause accumulations of oil at these points since the propane is vaporized before returning to the refrigeration unit. Since in some designs of alkylation reactors it is not possible to drain the refrigerant side, any oil accumulation may result in seriously decreased efficiency of operation. This situation may be relieved by bleeding a small quantity of liquid from the propane accumulator drum back to an alkylation-unit surge drum, operating at a lower pressure than the propane drum, which will permit subsequent processing of the contaminated propane on the alkylation unit fractionating equipment. As a result, the propane will be fractionated from the lubricating oil, the oil will be rejected with the heavy alkylate product, and the propane recovered together with the makeup propane from the depropanizer-tower overhead.



View of refrigeration building, showing propane storage tank (foreground), receiver, suction trap (right) and condensers (on roof)

Pipe clogged by scale to HALF its efficiency

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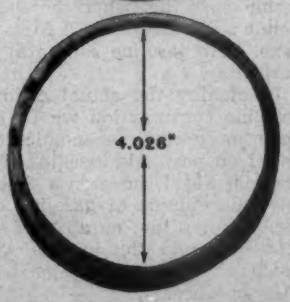

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Gasoline Consumption

(Continued from page 134)

works planning and the decentralization of cities will raise any possible saturation point which was being approached under prewar conditions.

7. The accumulated savings of probably 100 billion dollars in the hands of the consuming public will affect gasoline consumption only insofar as the cars on the road are put to use. The number of cars on the road will be limited by unavoidable scrappage and by the capacity of manufacturing plants to replace these scrapped vehicles and fill an expanding demand. Within the 5-year period after the war the so-called "hot" savings which make up approximately one-third of the total savings, will have been expended to a considerable degree on such consumer goods as dwellings and durable household equipment.

8. According to our method of relating consumption to the national economy, we have made certain assumptions regarding employment, income and production levels for the 5 years from 1945 through 1949.

TABLE 1

	Millions of persons				
	1945	1946	1947	1948	1949
Manufacturing, mining, transportation and construction	17.5	18.0	19.0	19.5	19.0
Other nonagricultural employment	20.7	18.7	20.8	21.0	20.0
Total nonagricultural	38.2	36.7	39.8	40.5	39.0
Agricultural employment	9.0	9.8	10.2	10.5	10.5
Military	8.0	4.0	3.0	2.5	2.5
Unemployed	6.5	8.0	6.0	6.0	8.0
Total labor force	61.7	58.5	59.0	59.5	60.0
Per cent employed	88.0	85.3	89.2	89.5	86.1
Hours per week	42.0	40.0	39.0	38.0	35.0
Total man-hours (millions per week)	2,054	1,958	2,062	2,064	1,890
Index of manufacturing man-hours (1939=100)	127.8	125.1	128.8	128.9	115.6
Real hourly earnings (cents per hour)	79.0	73.9	75.4	77.5	77.6
Industrial production (1939=100)	140.1	141.2	152.2	159.7	150.4
Income payments (billions gasoline dollars)	96.5	87.8	95.9	96.8	84.0

Bases for Estimates

We have constructed our estimating formulas so that when the above economic series are revised from time to time, new gasoline estimates can be derived.

In making the actual estimates of gasoline consumption we first developed a normal economic demand based on past relationships. The diagram in Fig. 1 shows in a simple way how the volume of gasoline demand depends on the number of persons employed and the income which is paid to them for the goods which they produce.

After the normal economic demand was determined, it was used as a base from which to make adjustments for conditions expected to result from the war. These adjustments are as follows:

1. The effect of rationing in the early postwar period.

2. The effect of unreplaced scrappage during the first 3 postwar years.

3. The effect of changes in aviation and military requirements for all postwar years.

4. The effect of interregional shifts in population as a result of the war.

The normal economic demand for the total United States as derived from the related national income and production data is shown in Column 1 of Table 2.

The expected consumption, after making adjustments for rationing, scrappage, military and aviation requirements, is shown in Column 2 of Table 2.

TABLE 2—TOTAL UNITED STATES GASOLINE CONSUMPTION

(Millions of 42-gal. bbl.)

Year	Normal economic demand	Final estimated demand including aviation
1945	653.8	598.7
1946	659.2	640.2
1947	696.8	699.9
1948	719.2	753.9
1949	719.0	755.5

Note: Total United States consumption 1939: 555 millions of 42-gal. bbl.

A picture of the relationship of the above adjusted economic demand to the normal economic demand is shown in Fig. 2. This chart divides the entire period from 1929 to 1949 into three subperiods. The base period extending from 1929 to 1941 during which actual gasoline consumption figures were available, is the period from which the estimating formula was developed. The war period, 1942 through 1944, represents the war years during which estimates do not apply, because no effort was made to measure the impact of the war on gasoline consumption in this analysis. (Estimates of the ration demand from other sources are shown as "x" in the chart.) The postwar period extends from 1944 through 1949, which is the period encompassed by this report.

A solid line represents the actual volume consumed during the base period. The broken line is the estimated consumption based on the formula developed from the base period. In the postwar years the estimated economic demand is shown as a broken line and the final demand after adjustment for scrappage, rationing and aviation at the postwar

This striking view of a gas cycling and processing plant was made for Petroleum Engineering, Inc., by Robert Yarnall Richie. The plant is one of many designed and constructed by this company during the past 15 years of continuous service to the industry, including cycling, repressuring, vapor recovery, and pure hydrocarbon plants. *Petroleum Engineering, Inc. Offices: Tulsa and Houston.*

rate is represented by a solid line.

It will be seen that in the base period the estimated quantity and the actual quantity follow closely except in the years 1932 and 1933. The percentage variation or residual is shown in the bottom part of the chart. The formula from which the estimates were derived is shown at the top of the chart.

An illustration of the stability of gasoline in our national economy is shown in Fig. 3.

During the period from 1919 to 1941 three depressions have occurred:

1. In 1921 the national income fell from 70 billion dollars to 52.5, while total gasoline consumption increased slightly.

2. In the latter part of 1929 income started to fall and continued downward for 3 years. The total drop was from 83 billion dollars in 1929 to 40 billion dollars in 1932. During this period gasoline consumption rose for the first 2 years, then fell slightly in the third year. Beginning in 1933 both gasoline and income rose.

3. During 1938 income dropped from 71.5 billion to 64 billion dollars but gasoline rose slightly. Since 1938 both income and gasoline have been rising.

We have plotted our estimates of normal economic demand for the 5 postwar years on the same chart in broken lines. The income figures used in estimating gasoline consumption are not strictly comparable with national income figures but as they appear on the chart they show that our postwar estimates follow the same pattern as prevailed during the past three declines in income.

After making estimates for the entire United States we made estimates on a smaller basis for six different regions of the United States. This gave us the opportunity of checking our regional totals by comparing a summary of them with our United States estimate. The difference between this summary and the normal economic demand for the entire United States ranged from 0.1 per cent to 1.9 per cent for the 5 postwar years.

We do not give the figures for each region in this article because they do not conform with any general regional divisions of the United States. In general, however, we have drawn the following conclusions from our regional estimates:

1. Gasoline consumption in the North Atlantic and Middle Atlantic States increased faster than United States total consumption for the years 1931 through 1938. Since then the United States total consumption increased more rapidly than for these states and according to our estimates will continue to do so during the 5 postwar years.

2. Gasoline consumption in the North Central States has followed the United States rate of consumption very closely throughout the years from 1930 to 1941. This relationship will continue during the 5 postwar years except in 1945, when the Central States rate of consumption will be slightly lower than the United States rate, but in 1949 the Central States should consume gasoline at a more rapid rate than the U. S.

3. In the Southeastern States gasoline consumption lagged drastically behind the United States rate of consumption up until 1938 or 1939. Then the consumption in these states forged ahead of the United States average. During the postwar period this trend will continue, particularly in the deep south.

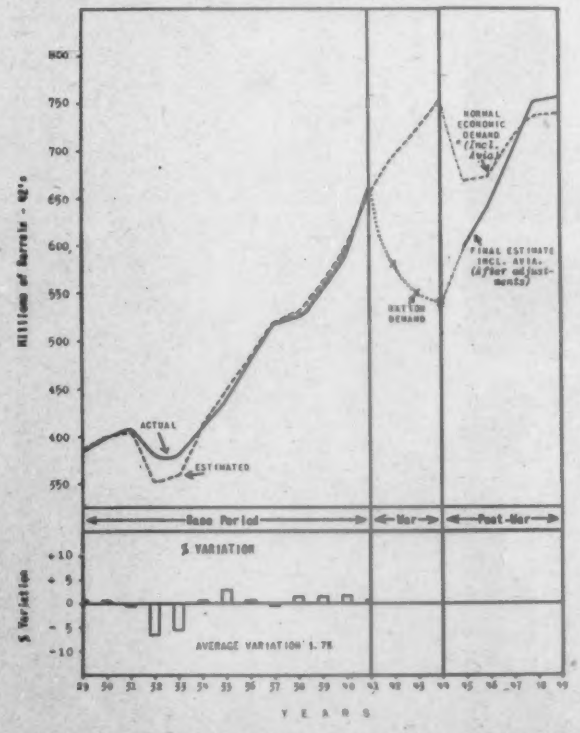
4. The South Central States followed somewhat the same pattern as the Southeastern States but with less variation from the United States rate of consumption. In the postwar years these states will consume gasoline at a faster rate than the United States but for the year 1949 their rate of consumption will be approximately the same as the United States.

5. The Western States consumed gasoline at approximately the same rate as the United States during the years from 1933 to 1941. In the latter postwar years, however, the Western States will increase more rapidly than the United States average until 1949 when the consumption will probably be about the same rate.

Our sales research department is now working on the relationship of the other principal products to national economic data. As a result of the formulas developed it will be possible to measure at any time the impact of changes of employment and income levels on the demand for the products of our industry.

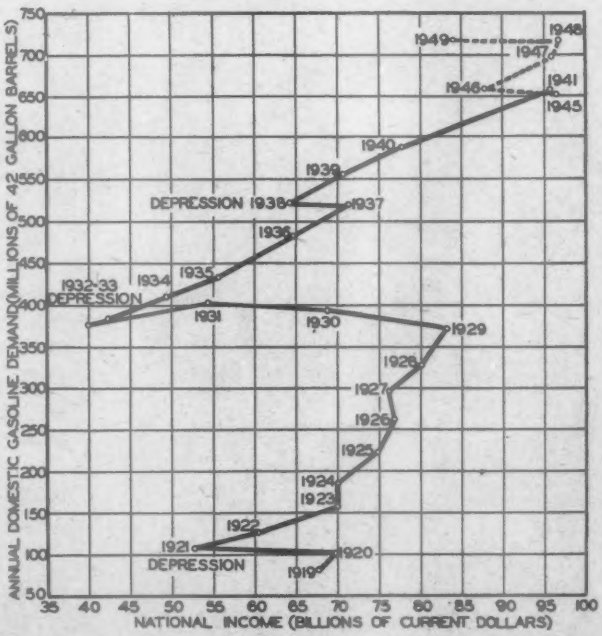
FIG. 2: ESTIMATED POSTWAR GASOLINE CONSUMPTION—U.S. TOTAL

Gasoline = 442.4 Log (Inc. Pay) + 19.32 (Year-1935) — 3.3 (Work Week) — 210.7



*Normal economic demand to which aviation gasoline has been added to prewar rates of increase.

FIG. 3 — TOTAL U.S. GASOLINE CONSUMPTION VS. NATIONAL INCOME—1919-1941



Oil-Well Pumping Practices—No. 33

Paraffin Important Problem In Hydraulic Pumping

by J. Zaba

AS stated in the preceding installment, paraffin is an important problem of hydraulic pumping since paraffin deposits both inside of power tubing and inside of production tubing have to be dealt with. There is also the question of paraffin in lead lines from the power unit to the well head.

Because of the presence of power oil in the high-pressure part of the hydraulic pumping system several methods of removal of paraffin in surface power lines and in power tubing are possible and are being used. Heating of power oil is an obvious remedy. In case of long lead lines from the power unit to the well head small auxiliary heaters are sometimes used on the lead lines, at some intermediate point between the power unit and well, in order to reheat the oil to the temperature it had at the time it left the central plant.[1] In some cases the method of heating the power oil may keep the lead lines clean but transfer the difficulties to well tubing.[2] Other methods are then applied.

A very efficient method of cleaning the paraffin from the high-pressure part of the system is use of oil-soluble plugs. A soluble plug of proper size is inserted at the discharge of the power unit and is pumped through the surface line and down the power tubing to the bottom. The plug becomes soluble at the bottom-hole temperatures.

For cleaning paraffin out of lead lines a unique method is used in some Illinois installations. A rubber ball ½ in. to ¾ in. larger than the diameter of the pipe is inserted back of the manifold of the power unit. The ball is then forced through to the well-head connection where it is retrieved. Some of these leases are flooded during certain seasons of the year. To make possible removal of paraffin, without special difficulties, during this part of the year plug receivers, consisting of 7-ft. sections of 7-in. casing are installed in the power lines. The rubber balls are caught in these receivers and can be removed later during the dry season.

Removing paraffin from the production tubing represents a more difficult problem. Here again a number of different methods are available. One of these methods is of preventive nature. Paraffin has a tendency to form the deposit at the point the gas comes out of solution from the pumped fluid traveling upwards through the annular space between production tubing and casing. By holding gas in solution the deposition of paraffin can be minimized. In case of hydraulic pumping this can be accomplished by holding the back pressure on the production tubing until solid pump strokes appear on the gage indicating that the pressure is sufficient to hold the gas in solution and that a solid fluid column is in the tubing.[3]

Of the several methods of actually removing paraffin from the production tubing two are particularly effective.[4] One is that of rotating the power oil tubing. This causes scraping action inside of production tubing and loosens the paraffin so that the pumped oil will force it out of production tubing. By installation of high-pressure swivels in power-oil tubing below the paraffin zone and above the well-head connection this turning of power tubing can be accomplished while the well is pumping. Another method consists of installation of a tubing crossover below the paraffin zone which allows the reversal of flow through the paraffin zone, of power oil and of produced fluid. Paraffin may be caused to be deposited inside of power tubing in the troublesome zone from where it can be quite readily removed. The crossover may also be used for pumping paraffin solvents or heated power oil into the paraffin zone.

Another method[5] of removing paraffin consists of pulling the pump and scraping the paraffin ahead of it. The paraffin thus loosened falls down in the hole and is pumped out after the well is put back again on production. Application of chemical paraffin solvents is also practiced.

Operating Pressure

Pressure required for operation of a hydraulic pump depends on the static pumping head and friction. For the purpose of estimates, the operating pressure, in pounds per square inch, of a hydraulic pump with piston areas ratio of 1:1 is usually taken as 40 to 50 per cent of the pumping head, in feet.

The operating pressure as shown by the surface gages is a good indication of bottom-hole conditions of the well and of manner of operation of the subsurface part of the system. Within certain limitations bottom-hole pressure and the well's productivity may be quite closely estimated. This subject will be discussed later in more detail.

Capacities

Factors affecting the capacities of hydraulic pumps are pump diameter, length of stroke, speed of plunger, fluid acceleration and friction loss in tubing.[6] Friction losses in power tubing add directly to the operating pressure. Friction losses in production tubing add friction head to the pumping head, increase therefore the operating pressure. Also, they put back pressure on the exhaust of the hydraulic engine, add therefore direct-

TABLE 1—CAPACITIES OF HYDRAULIC PUMPS

Nominal pump size	Stroke in.	Piston size, Engine	Piston size, Pump	Area ratios, E/P	Area ratios, P/E	Rated speed SPM	Pump displacement at Rated speed B/D	Max. setting depth
2 x 1⅛	12	1	1⅛	2.40	.55	83	72	15,000
2 x 1	12	1	1	1.00	1.00	83	174	10,000
2 x 1 7/16	12	1	1 7/16	.63	1.55	83	270	6,300
2½ x 1	18	1¼	1	1.92	.52	71	182	15,000
2¼ x 1⅛	18	1¼	1⅛	1.34	.75	71	261	13,400
2½ x 1¼	18	1¼	1¼	1.00	1.00	71	349	10,000
2½ x 1 7/16	18	1¼	1 7/16	.70	1.43	71	500	7,000
3 x 1	24	1½	1	3.86	.26	64	157	15,000
3 x 1¼	24	1½	1¼	1.69	.59	64	385	15,000
3 x 1⅜	24	1½	1⅜	1.27	.79	64	475	12,700
3 x 1½	24	1½	1½	1.00	1.00	64	604	10,000
3 x 1¾	24	1½	1¾	.68	1.48	64	896	6,800
4 x 1½	30	2	1½	2.40	.42	57	498	15,000
4 x 1¾	30	2	1¾	1.46	.69	57	822	14,600
4 x 2	30	2	2	1.00	1.00	57	1,200	10,000
4 x 2⅜	30	2	2⅜	.65	1.55	57	1,850	6,500
4 x 6 x 2⅜	30	2	2⅜	.51	1.96	57	2,350	5,100
4 x 6 x 3	30	2	3	.38	2.68	57	3,190	3,800
4 x 6 x 3½	30	2	3½	.27	3.75	57	4,485	2,700

BAKELITE GUIDES GIVE 30% MORE STRENGTH

The above picture shows method used to determine comparative strength of shoes equipped with Bakelite guides and shoes made with the older style concrete guide. The tests were conducted by oil company engineers.

The Bakelite nose of the guide shoe tested began to fracture at 250,000 pounds but did not give away completely until 320,000 pounds were applied.

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Note (in white circle) Bakel nose begins to collapse. Note (left) nose collapsed completely 320,000 pounds.

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ly to the operating pressure. The friction factor is usually not over 10 per cent of the operating pressure. Fig. 1 gives the capacity of different tubing combinations as a function of fluid viscosity for friction equal to 10 per cent of the operating pressure.

The motion of the pump plunger approximates simple harmonic so that the acceleration factor can be written as N^2L where N equals the number of strokes per minute and L the length of stroke. The capacities of different size pumps as a function of acceleration factors for which the pumps are designed are shown in Fig. 2.

Piston Areas Ratio

A standard hydraulic pump has the piston area of the engine equal to the piston area of the pump. By changing the ratio of the areas of the two pistons many different combinations of different operating conditions can be met. These conditions are the operating pressures, the amount of fluid handled, and the pumping depth.

Table 1 illustrates the flexibility of hydraulic pumps resulting from changes of the engine-piston to pump-piston area ratio. It can be seen for instance that for a 1-in. engine-piston pump, for the same length of stroke and for the same rated speed of operation the pump displacement depending on size of pump piston may be 72, 174 and 270 bbl. per day for corresponding maximum pumping depths of 15,000, 10,000 and 6,300 ft.

To illustrate this flexibility from the standpoint of operating pressure

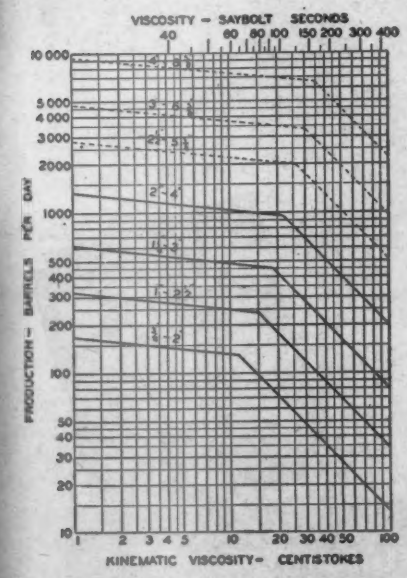
VISCOSITY – SAYBOLT SECONDS
40 60 80 100 150 200 300 400
PRODUCTION – BARRELS PER DAY
KINEMATIC VISCOSITY – CENTISTOKES
1 2 3 4 5 10 20 30 40 50 100

Fig. 1: Capacity of tubing combinations as function of viscosity for friction loss equal to 10 per cent of operating pressure. (From "Hydraulic Power Applied to Oil-Well Pumping."—C. J. Coberly, Drilling and Production Practice A.P.I., 1935, p. 84).

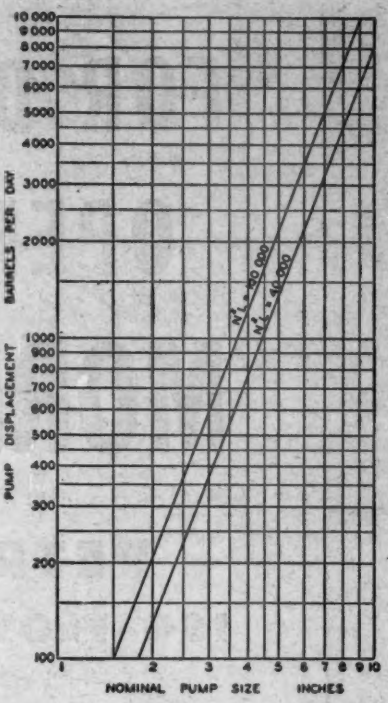

Fig. 2: Capacity of hydraulic pumps as function of acceleration factors

a case can be cited of one of California installations.[1] The installation in question operates wells with pumping depths of 4,500, 6,000 and 6,500 ft. A uniform pressure of 3,000 lb. is maintained on the power unit and the ratio of plungers used in the shallower wells, 1¼ power-end plunger with 1⅞ pump plunger, corrects this pressure to the one needed for the shallower depth.

Efficiency

The over-all efficiency of hydraulic pumping installations is quite high compared with other methods of mechanical lift.

Study of electric-power requirements for pumping oil wells (referred to in Installment 17) included, among other methods of mechanical lift, hydraulic pumping.[3] Four wells were considered producing from the depth of around 6,400 ft. with production ranging from 9,186 to 12,348 bbl. per month. The over-all efficiency, from electric meter to the fluid in tank, of these four installations was found to range from 54.0 to 60.5 per cent. The discrepancy in figures on efficiency for the four wells was probably due to formation of paraffin in wells showing lower efficiency. These figures agree quite closely with some later data collected on this subject. In calculations of hydraulic pumping installations the over-all efficiency is usually assumed as 60 per cent.

Installation Practices

Because the method of hydraulic pumping is comparatively new and as such is not hampered by established habits and customs and because it requires well-engineered advance planning, many of hydraulic pumping installations are characterized by highly efficient features in different component parts of the system.

One of such features is use of heat exchangers for heating of power oil with hot engine water. This arrangement serves at the same time the purpose of cooling the engine water used in the prime movers serving the installation. In one case the heat exchanger consists of a 750-bbl. tank full of clean power oil with horizontal coils through which the engine water is circulated.[2] One or two coils may be taken out of the circuit so that varying degrees of temperature of both oil and water may be obtained. Other interesting features include arrangement of settling systems for power oil, manner of manifolding lines at the power unit to simplify operation and inspection of control valves and gages, manner of installing the power unit itself and the gas lines, electric conduits and drain lines to assure clean and orderly appearance and others.

In planning a multiple installation[4,5] arrangements are usually made for ultimate requirements of the plant. Piping, houses, and tanks are arranged in such a manner that addition of new units can be made without disturbing original installation. The surface power lines are provided with tees, plugs and valves placed at suitable locations for use with soluble plugs for cleaning of paraffin.

Use of power-oil and production meters and of recording pressure gages facilitates study of operations. Positive-type flow beans, together with constant discharge pressure, control the rate of input of oil. Automatic safety controls in form of pilot-operated bypass valves and mercoid switches protect the system respectively against sudden stoppage of demand or failure of supply of the power oil.

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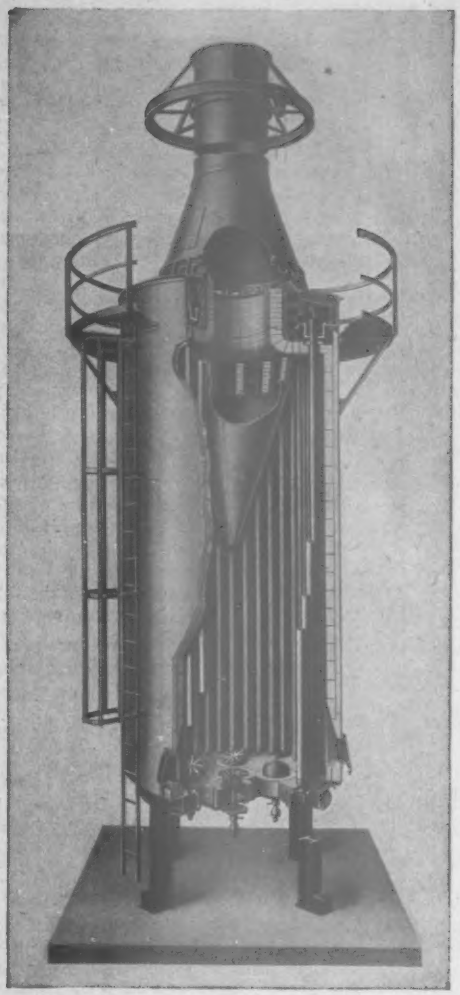

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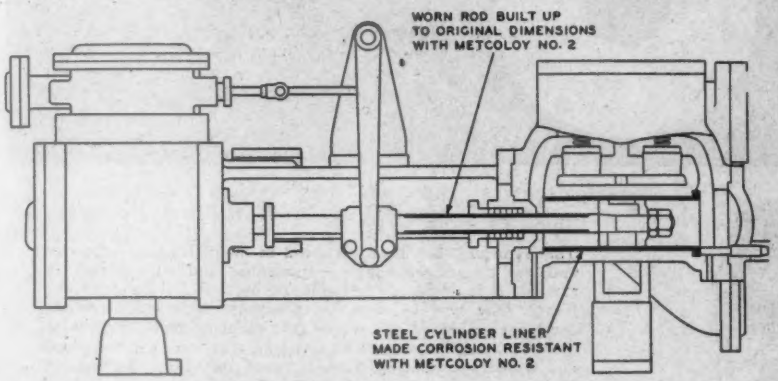
PROGRESS IN METALS

by W. L. Nelson

Metallized Pump Cylinder Lines

THE successful repair of worn pump-cylinder liners and shafts of steam pumps, and the bearing surfaces and steam seals of a steam turbine is reported in the September-October 1943 issue of Metco News (Metallizing Engineering Co., Inc., Long Island City, N. Y.). Both of these equipments are in service at the Freedom Oil Co. plant at Freedom, Pa.

The reciprocating steam pump shown in the accompanying illustration is used in pumping crude oil



containing sulfur, ammonia, salt, and water at a high pressure. Plain cast-iron cylinder liners had, in the past, lasted less than 6 weeks before repairs were necessary. After metallizing these liners with Metcoloy No. 2 stainless steel at a cost of about $25 per liner, a continuous service of more than a year has been accomplished. Those in charge of these pumps believe that the liners will last another 5 years.

In these times, not the least advantage of repairing by metallizing, is the time saved. Replacements of machine parts may require several weeks or months and even repairs in local shops will usually entail more delay than required by metallizing in the plant shop.

Types of Rust Preventives

RUST preventives containing the nondrying types of oils have a wide range of applications. Among their characteristics are, excellent protection, sufficient durability with economy, freedom from cracking and peeling from the metal surface, ready removal with petroleum solvents, and lubricating qualities which make it necessary to remove them for many subsequent uses of the treated part.

In recent years many improvements have been made in this type of rust preventive. These improvements include the development of types for special uses and the development of rust-preventive addition agents which definitely inhibit rust formation. The following types are available:

Solvent type.—This type contains a high percentage of Stoddard solvent as a vehicle for the grease and rust preventive. It is recommended for indoor protection against both humid and acidic atmospheres. It may be applied by dip, spray, brush, or swab, and covers about 1,200 sq. ft. per gal.

Fluid type.—This type contains lubricating oil as the vehicle and gives somewhat better protection than the solvent type. It is useful for protecting small parts for indoor storage. It covers 650 sq. ft. per gal., and may be applied by dip, spray, brush or swab.

Plastic type.—This type is suited for use on parts that are to be stored either inside or outdoors. The thickness of the film is sufficient to protect against the impingement of rain. This type can be poured at normal room temperatures but may be heated for ease of application. Application may be made by dip, brush, or swab. Dip application coverage is about 200 sq. ft. per gal.

Solid type.—This type is intended for outside use where severely corrosive conditions require a permanent, highly resistant, semihard coating. The film hardens slowly on the outside but remains soft and plastic next to the metal. It may be applied by dip, brush, or swab. When applied at 175° F., the coverage is approximately 80 sq. ft. per gal.

Abstract: J. S. Norris, Monthly Review, Am. Electroplater's Soc., Vol. 30, Aug. 1943, p. 724-728. Taken from Dec. issue of Metals & Alloys.

Recovery of Scrap Metals

THE absence of world statistics on the recovery of scrap makes it impossible to give a comprehensive picture of its full significance. However, it is clear from the data on hand that scrap recovery will be of increasing importance with regard to the conservation of metal resources, and that as a major source of raw materials it must be brought into any general scheme affecting them under the Atlantic Charter.

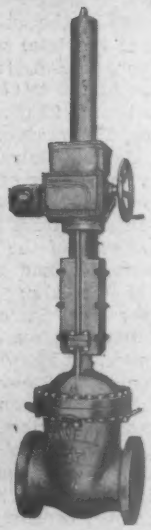
At present iron and steel represent about 93 per cent of the total world tonnage of metal production. It has been estimated that of the total output of iron and steel, 15 to 20 per cent is lost from rusting. The recovery of ferrous scrap in United States has reached in recent years 75 per cent.

American statistics for 1929-38 show a recovery of metallic tin from scrap amounting to 8 per cent of the total consumption as pure tin and alloy, and a recovery in the alloy form amounting to 26 per cent. Same statistics show that out of a total production of 1 million tons of aluminum, one-fifth came from scrap recovery. In addition, about 225,000 tons of aluminum was recovered in the form of various alloys, making the total contribution of scrap to consumption about 35 per cent.

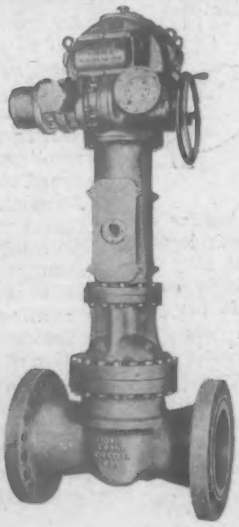
United States domestic consumption of copper for 1929-38 was approximately 6.5 million tons, of which 2.5 million tons or 39 per cent came from scrap recovery. Scrap recovery of nickel has progressed steadily, and in 1938 was about 2,000 tons, which is, however, only a small percentage of consumption. Little is known about the recovery of chromium.

An abstract: Harold Hartley, Foundry Trade J., Vol. 69, Mar. 25, 1943, p. 245. Taken from Metals & Alloys, July 1943.

ER 90%



Type G.



Type S.C.

Type G.

This type unit has been installed in many leading refineries and has proved extremely dependable and trouble-free in service. It is designed for mounting on top of the valve yoke flange. The type G. consists essentially of a motor driven combination helical and worm gear reducing mechanism with limit and torque switches in a rugged cast iron, weatherproof and dust-tight housing. Can be used on valves up to 96" diameter.

Type S.C.

In this Type S.C. LimiTorque, a crank type mechanism is employed. This enables it to open and close valves much faster than can a conventional type operator. For example a 24" valve can be opened under full unbalanced conditions in only 3 seconds, instead of the usual 15 or 20 seconds. Further, it is so trouble-free in service that it can be operated for a year or more without the need of shutting down the line for repairs or adjustments to the control. Hundreds have been installed or specified for use in the production of butadiene, toluene or aviation gasoline.

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RAPID RETURN ON INVESTMENT

PROBABLY more than in any other industry, a quick return on investment is considered to be of prime importance in oil operations. Much of this business philosophy stems from the period when oil properties were developed on borrowed capital and quick investment returns were essential.

When different development programs, reconditioning measures, and other operations are under consideration, a cost analysis usually includes some provision for interest which accumulates from the profits. Frequently, it is necessary to determine the relative profits to be derived by different withdrawal rates. As an example of this type of analysis, a well is producing at the rate of 20 bbl. of oil per day. By the installation of new equipment and an added investment, the daily production rate can be increased to 35 bbl. of oil per day. This faster rate of withdrawal does not necessarily mean that the ultimate amount of oil recovery will be greater. However, the value of this oil production is greater since the money is returned in a shorter period of time and will accumulate interest. The interest rate to be applied may vary according to the various operators, although figures of 5 or 6 per cent are ordinarily used.

Since such a change in operation involves additional investment and perhaps a change in operating and repair expense, it is necessary to consider these factors in the cost analysis. In general, the plan which derives the greatest amount of profit is the one which is economically desirable.

A cost analysis of this type is shown in the accompanying tables. This particular well was producing 33 bbl. of oil and 450 bbl. of water per day. The rate of production was limited by the equipment at the well. Operating data and estimates indicated that the production rate could be increased to 50 bbl. of oil per day by installing new equipment. The estimated cost of installing this new equipment amounted to $6,850. The anticipated decline curves for the two different withdrawal rates are shown in Fig. 1. The ultimate amount of oil recovered by either method was approximately the same. It will be noted, however, that at the faster rate of withdrawal, the oil could be obtained in 5 years, whereas the slower rate of withdrawal of the oil would require 9 years.

The gross oil production by years was estimated from the decline curves. The net production was based on a seven-eighths working interest. The value of the net production was calculated on the basis of $1.21 per barrel. Operating and repair expense was based on past records at wells with similar operating conditions. In order to compare the amount of profits on the same basis, the net profits plus interest at a rate of 5 per cent, which would be accumulated on January 1, 1953, is shown in the final column.

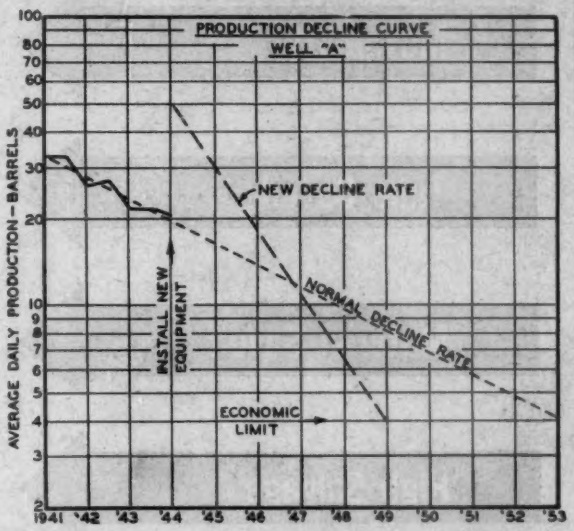

Fig. 1

TABLE 1—ESTIMATED PRODUCTION AND PROFITS AT PRESENT WITHDRAWAL RATE

Year—	Estimated gross prod. (bbl.)	Net prod. (bbl.)	Value of net prod.	Operating and repair expense	Net profit per year	Value of profit on 1-1-53
1944	6,500	5,680	$6,870	$1,680	$5,190	$7,500
1945	5,480	4,800	5,820	1,680	4,140	5,825
1946	4,610	4,040	4,890	1,680	3,210	4,300
1947	3,870	3,380	4,090	1,680	2,400	3,060
1948	3,270	2,860	3,460	1,680	1,780	2,160
1949	2,740	2,390	2,890	1,680	1,210	1,402
1950	2,300	2,010	2,430	1,680	750	828
1951	1,930	1,690	2,040	1,680	360	378
1952	1,640	1,430	1,730	1,680	50	50
Total	32,340	28,280	.....	$15,120	$19,090	$25,503

TABLE 2—ESTIMATED PRODUCTION AND PROFITS WITH INCREASED RATE OF WITHDRAWAL

Year—	Estimated gross prod. (bbl.)	Net prod. (bbl.)	Value of net prod.	Operating and repair expense	Net profit per year	Value of profit on 1-1-53
1944	14,650	12,300	$14,890	$2,050	$12,840	$18,970
1945	8,580	7,520	9,100	2,050	7,050	9,320
1946	5,110	4,470	5,680	2,050	3,630	4,650
1947	3,100	2,720	3,296	2,050	1,240	1,580
1948	2,010	1,760	2,130	2,050	80	97
Total	32,850	28,770	.....	$10,250	$24,840	$35,427

From the comparison shown in Table 3, the faster rate of withdrawal would provide an additional profit of approximately $4,700.

TABLE 3—COMPARISON OF PROFITS FROM TWO WITHDRAWAL RATES

(A)	Present withdrawal rate:	
	Profit (based on 1-1-53)	$25,503
	Salvage value of equipment	780
	Total profit and salvage value	$26,283
(B)	Increased rate of withdrawal:	
	Profit (based on 1-1-53)	$35,427
	Less investment on new equipment	6,850
		$28,577
	Plus salvage value of equipment	2,400
	Total profit	$30,977

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Engineering Fundamentals

No. 132

A FEATURE OF THE OIL AND GAS JOURNAL

MEASUREMENT OF pH VALUE

TWO methods of determining the pH value of rotary drilling fluid have been found to be satisfactory and are approved as standards by the A.P.I. These methods are: (1) Modified colorimetric method, (2) electrometric method.

Colorimetric Method

The colorimetric method employs gelatin indicator strips which are immersed in the mud and then matched by color with a standard scale from which the pH value may be read. Each of the standard color scales is marked off by progressive changes in tint between two colors and covers a pH range of about 2.5. Adjacent tints on a given color scale represent a change in pH of about 0.2 unit. Each color scale has an individual set of gelatin indicator strips.

Each group of indicator strips is impregnated with a separate dye which, when exposed to a water solution or water mixture, will assume either one of two colors or a tint between the two colors, depending upon the pH value of the solution and the particular gelatin strip chosen. If the proper gelatin strip is chosen, it will assume a tint intermediate between the color extremes of its scale. For example, a gelatin strip that is indicated for use between a pH of 8.2 and 10.8 when exposed to a water solution will change to a chrome yellow if the pH of the solution is below 8.2 or to a prussian blue if the pH is above 10.8. However, the strip will assume a tint between yellow and blue if the pH falls between 8.2 and 10.8, and the pH is determined by matching this tint with the color scale and reading the corresponding pH from the scale.

A sand-glass timer is provided as a part of the apparatus to enable the operator to determine when the indicator strip has been immersed in the sample for 1 minute. If the pH does not fall within the range of the indicator strip used, the determination is made again, using an indicator strip of the proper range.

In order to avoid erroneous results, care should be taken to prevent contamination of the solution or of the gelatin strips before taking a reading. Distilled water and a clean cheese cloth or filter paper should be used for cleaning the apparatus. A clean pair of forceps should be used for handling the gelatin strips.

It should also be remembered that it is the tint or color, rather than the intensity thereof, that is to be judged. The test solution may leach out the dye sufficiently that its intensity is only a fraction of that of the corresponding color on the scale. If the gelatin strip is folded double the intensity of its color also will be doubled but the actual tint or color of the strip will not be altered. Strips should be doubled only to increase the intensity of color.

The A.P.I. recommendations state that this method is not applicable to salt-water muds.

Electrometric Method

Several glass-electrode pH instruments are on the market. Desirable features of an instrument to be used in testing drilling muds include durable construction, simplicity of operation, and minimum attention to maintenance. Instruments meeting these requirements include those manufactured by Coleman, Leeds & Northrup, and Beckman. The Beckman industrial model pH meter is widely used in mud testing and will be described as representative of the glass-electrode instruments.

The instrument measures the hydrogen ion concentration (pH) of a solution by determining with a potentiometer the voltage developed by two electrodes that are in contact with the solution. The voltage of one electrode is fixed while the voltage of the other varies with the pH of the sample under test. A vacuum tube is used to amplify the current, since the resistance of the circuit is high.

In making a test, the first step is to standardize the instrument using the following procedure:

1. Make sure pushbutton in front right corner of panel is in "up" position.

2. Turn the selector (in center at front edge of panel) to the "on" position and permit 1 minute for warming up.

3. Turn the selector to the "7-14" position and adjust the front left-hand knob until the pointer of the voltmeter reads exactly 7 pH.

4. Turn the selector to the "0-7" position and adjust the STD dial until the pointer reads exactly 7 pH.

5. Flush calomel electrode by removing the small rubber stopper on the side, momentarily loosening the ground glass sleeve at the bottom, and allowing a drop of the potassium chloride solution to run out of the small hole in the ground joint.

6. Wash both electrodes with distilled water.

7. Select the buffer solution nearest to the pH of the sample to be tested. Add this buffer solution to the small test beaker, and rinse the cells several times by dipping them into the beaker.

8. Discard the buffer solution used for rinsing.

9. Refill the beaker with fresh buffer solution, insert the electrodes and allow to stand 1 minute.

10. Depress button at front right-hand corner of panel and read pH on the voltmeter dial.

11. If the reading does not correspond to the known pH of the buffer solution, turn AP dial until it does.

The pH of the test sample is next determined by the following procedure:

1. Rinse the beaker and the electrodes several times in a portion of the test sample.

2. Discard that part of the sample used for rinsing.

3. Refill the beaker with fresh sample, insert the electrodes and allow to stand 1 minute.

4. Depress button, and read pH from the dial of the voltmeter.

Accuracy of results obtained with this instrument is not affected by oxidizing or reducing agents, gases, dissolved organic compounds, colloids, or suspended matter. A higher degree of accuracy is obtainable than with the colorimetric method; since the glass-electrode instrument will easily indicate pH to the nearest one-tenth of a unit, and readings are possible within 0.02 unit. If the test sample contains a high concentration of sodium salts, a correction must be made; a set of curves is furnished for this purpose with each instrument.

References

A.P.I. Code 29, second edition, July 1942, "Recommended Practice on Standard Field Procedure for Testing Drilling Fluids (Tentative)."

Stern, A. George, "Role of Clay and Other Minerals in Oil-Well Drilling Fluids," U.S.B.M. Report of Investigations 3556, Feb. 1941, p. 46.

Sales literature of Baroid Sales Department, National Lead Co.

Instructions furnished with Beckman pH meter (industrial model).

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N.G.A.A.

War Products and Postwar Planning Conference

James W. Vaiden, association president, and vice president of Skelly Oil Co., Tulsa

DALLAS, Tex.—Interest in the annual meeting of the Natural Gasoline Association of America will reach a climax here April 14, the final of a 3-day conference, with the "information please" session at which most of the industry's technical, and operating problems will be discussed.

Previously, those composing the near-record registration list heard technical papers dealing with three specific phases of operations. One section was devoted chiefly to natural gas, natural gasoline and liquefied petroleum gases. Another dealt principally with condensate and high-pressure gas operations. The "information please" panel discussion on the closing day, judged on the basis of questions already submitted, will touch on all phases with special emphasis on cycling.

James W. Vaiden, president of the N.G.A.A., and vice president of Skelly Oil Co., Tulsa, set a new precedent. He discarded the custom of reviewing the industry's accomplishments and projecting the future trend, a time honored prerogative of association presidents. In place of the usual presidential address, Vaiden invited those attending the meeting to avail themselves of the opportunity to learn more about their industry by paying close attention to the technical papers and by broadening acquaintanceship.

E. O. Bennett, Houston, consulting engineer, reviewed development of centrifugal compressors and summarized operating conditions under which they are adaptable. He suggested that operators should consider installation of centrifugal compressors in dealing with high pressures and large volumes of gas.

Spectrographic analysis of hydrocarbons was explained in a paper by H. Cary, National Technical Laboratories, Pasadena, Calif. The infrared spectrograph method was extolled for its accuracy and speed in making necessary plant analyses or gas.

James E. Pew, Washington, director of the Petroleum Administration for War's Natural Gas and Natural Gasoline Division, reported on progress of the plant-construction program which is expected to increase production of light hydrocarbons approximately 30,000 bbl. daily. He reaffirmed the necessity of raising production of isobutane, isopentane and allied products in the natural-gasoline and cycling operations in order to meet the projected manufacturing goals for aviation gasoline, synthetic rubber and certain critical chemicals.

High interest was registered in a paper by D. P. Barnard, associate director of research, Standard Oil Co. (Indiana), Whiting, which dealt with postwar relationship of refining to natural-gasoline operations. Much of the natural-gasoline industry's products now reserved for manufacture of aviation gasoline will be available for other commerce after the war is terminated, Barnard asserted.

Participation in the "information please" panel discussion will include James E. Pew, representing PAW; Darst E. Buchanan, president Hanlon-Buchanan, Inc., interlocutor, and E. O. Bennett, Houston, consultant

Increases in Natural-Gasoline Yield to Continue for Production of War Materials

*by G. L. Brennan**

This symposium on the future of the liquefied petroleum gas industry, presented this week at the annual meeting of the Natural Gasoline Association of America, reflects an expectancy that production will continue its upward trend. Some manufacturers anticipate a permanent demand for butane from the chemical industry which will tend to reduce the amounts available for fuel.

THE natural-gasoline industry with its growing production of various grades of natural gasoline, isopentane, normal butane, isobutane and propane, occupies a very important position in the war, since many of these products are essential in the manufacture of high-octane aviation gasoline, synthetic rubber and many other critical chemicals, fuel for industrial heat-treating processes of all kinds, primary and secondary supplies for gas utility companies, and a sole source of domestic fuel for some 2,000,000 families throughout the United States. The demand for normal butane-propane mixtures, isobutane and propane in most areas has exceeded the supply that could be delivered during the winter months of 1943 and 1944. This condition has been cause of widespread conjecture, guess work and forecasting, indicating to the program committee of this convention that the future of this part of the natural-gasoline industry was of more than ordinary interest.

This paper has resulted from answers given to a questionnaire sent to several of the more prominent producers and marketers of these products, the following submitting replies: Carbide & Carbon Chemicals Corp., Cities Service Oil Co., Lone Star Gas Co., Phillips Petroleum Co. and Warren Petroleum Corp. As a result it is believed that some reliable predictions can be made, although during the balance of the war period there can be such radical changes in high-octane gasoline production that many of the opinions regarding this subject could be reversed.

There are also several phases of the entire problem so involved in the refining and rubber industries, that no attempt has been made to cover them at this time. No attempt has been made to investigate the very troublesome transportation problem, as this, likewise, will be materially affected by the high-octane gasoline and rubber programs.

The balance of this report will state each question submitted to the various companies with condensed answers. These answers show the majority consensus together with comments on opinions which vary from this. Some of the more especially interesting statements are quoted verbatim.

Question 1.—Will the supply of propane, butane and mixtures increase or decrease in each of the periods mentioned above, namely: (1) Balance of war period; (2) immediate postwar period; (3) 3 to 4 years of peacetime developments, keeping in mind the demand for these products as fuel and raw material for 100-octane aviation gasoline and butadiene?

Answer 1.—Production of butane and propane and mixtures will increase during the balance of the war period to the extent that the supply of propane will no doubt be adequate to meet contemplated demands, but the amount of butane that will be available for the fuel markets during the coming winter will very probably be inadequate, and might bring about a shortage more acute than prevailed during the past winter. One company made the statement that it was very unlikely that there would be any increase in the supply of either of these products in so far as the fuel markets were concerned.

2. During the immediate postwar period, opinions, with one exception, are expressed that there will be plentiful supplies to large surpluses of all of the light hydrocarbons, although one company believes that the 100-octane aviation gasoline and rubber programs will be continued for some time after the war.

3. During 3 to 4 years of peacetime developments, there will be plentiful supplies of propane and butane, although the possibilities are good that the demand for butane in chemical processing plants may be competitive with fuel demands, thereby reducing the amounts available for sale through these particular channels.

Question 2.—What is your opinion as to any change in the relative value of propane versus butane at natural-gasoline plants due to possible new uses or expansion of present markets for these hydrocarbons?

Answer 2.—Predominant opinion on this question is that there will be little, if any, change in value of liquefied petroleum gas during the war or as long as government price control prevails, but that, when such controls are removed, the value of butane will probably increase, although one producer feels that the value of propane versus butane will be in reverse due to the fact its higher cost of manufacture must net back more at the plant. Perhaps one of the best comments on this question of all submitted, is as follows:

"Based upon the assumption that governmental price control will continue for the war period and for some time into the immediate postwar period, there should be no material changes in prices of propane, butane or mixtures until some time after the war is over. When economics again dictate relative prices, it is expected that the value of butane will increase with respect to that of propane due to the greater process value of butane in the manufacture of motor fuels, aviation gasoline, synthetic rubber and other chemical products."

Question 3.—In your opinion, do you expect important changes in methods and costs of transportation of liquefied petroleum gas, keeping in mind tank-car, transport-truck or barge movement?

Answer 3.—The answers to this question vary markedly, but all are agreed that methods of transportation will not change materially in any of the periods considered, but half be-

*Warren Petroleum Corp.

lieve costs will be lower in the future; others feel the long-term trend will be upward, and we quote one of the more interesting comments made on this subject, as follows:

"Future transportation means and cost are dependent upon many factors such as labor costs and weight and load restrictions by various states in the case of truck transportation, the decision of the I.C.C. on pending freight rate increases and weight per gallon used to calculate rail costs. Barge or tanker transportation may find limited fields of use. Future transportation costs are expected to increase rather than decrease."

Question 4.—What is your opinion as to the trend in demands for the following types of consumers: (1) Domestic (propane and butane); (2) industrial; (3) utility; (4) chemical; (5) internal-combustion engine; (6) refinery (blending, processing)?

Answer 4.—(1) The use of the word demand in this question may be misleading, and it should be defined, in view of the answers, to mean increased shipments and not increased demand from consumers, which demand cannot be satisfied due to restrictions on utilization equipment and appliances. All agree that increased shipments to domestic consumers can increase little, if any, during the war but that immediately after the war, this type of business will have a large increase; some feeling that propane volumes will grow more rapidly. Due to the shutdown of federal housing projects, there may be some decrease in demand immediately after the war is over. One comment on this subject is of interest, and we quote as follows:

"During the immediate postwar period and later, the domestic demand for both propane and butane will increase rapidly in line with the availability of utilization equipment and appliances, although it is very probable that higher percentages of propane may be used in mixtures distributed throughout the southern territory. However, improvements and refinements in utilization equipment may have a distinct bearing on the type of fuel used in the south."

2. Opinions on the industrial outlet for liquefied petroleum gases vary considerably, but it is apparent that there will be lower demand in the immediate postwar period due to industrial conversion programs but that after that time there will be a healthy increase. Several point out that this will be influenced materially by increased natural-gas distribution in large industrial centers.

3. Here again, opinion is divided, although it is apparent that immediately after the war utility use will probably decrease. Future demands depend somewhat upon distribution of natural gas, but the small town gas plants now using other raw material, offer a good market to develop.

4. Nearly all agree that there will be an increased use of liquefied petroleum gas in the chemical field, but that the volumes of propane may be relatively small compared to the total sales of this product, and further that butane will probably be in greater demand for chemical use than will propane when war restrictions on new construction are removed.

5. Consensus of answers to this question is that there will be some increase in the internal-combustion engine field, but the increases will probably be confined to special uses. One analytical comment on this subject is quoted below:

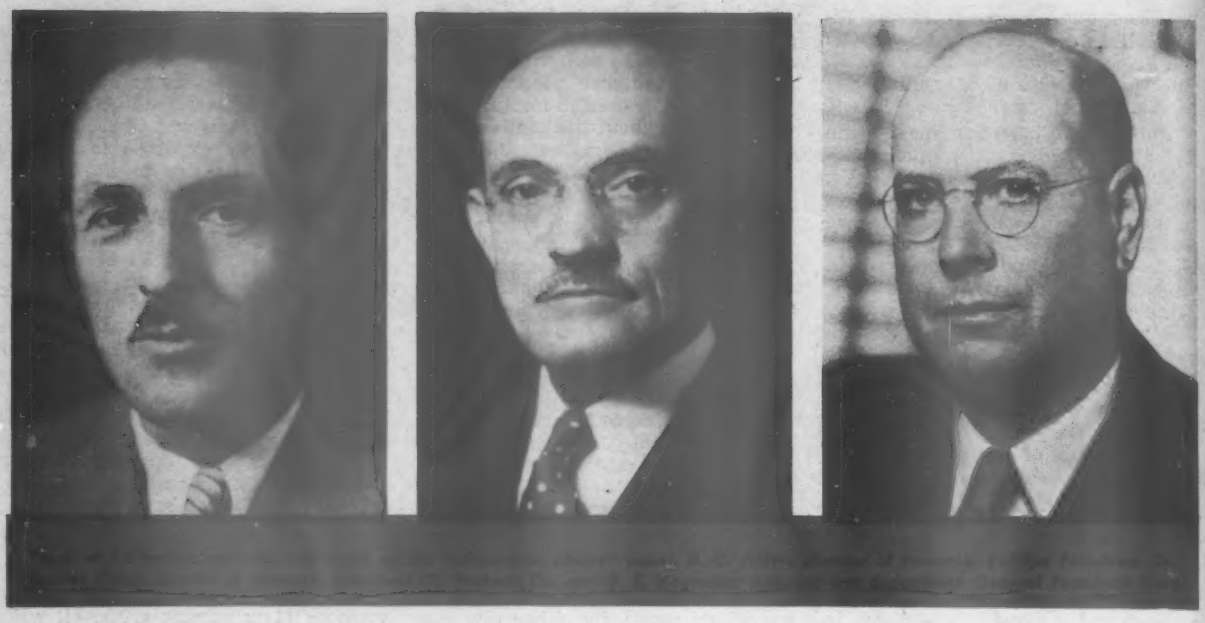
"No material increase in this type of use is expected although a limited amount of L.P.G. fueled heavy-duty hauling, construction and oil well drilling equipment is expected to continue using L.P.G. in those locations where definite economic advantages exist. Probable increased octane rating of motor fuels and improved engine design are expected to reduce the present incentive to use L.P.G. for many engine applications."

6. Answers to this question appear to be in variance and considerable guess work seems to have been done, but comments from two different companies, which are quoted below, are of considerable interest:

"The blending of butane by the refiner will, as in the past, consume a very large percentage of the total production for purposes of obtaining required vapor pressures. Of course, in the past, a great deal of this butane content of motor fuel has been contained in natural gasoline shipped to the refiner. With reference to processing butane or isobutane manufactured at natural-gasoline plants or refineries, the economics of various methods of processing crude oil will probably determine in each specific refinery, what, if any, processing of normal or isobutane will give the largest dollar return. It appears that processing of these materials may be seasonal, so that only the volumes in excess of required vapor pressure in motor fuel will be further processed. This comment is made on refinery production of motor fuel and exclusive of any chemical manufacturing involved directly or indirectly.

"Processing of butane, principally in refineries, will increase to some extent, but not greatly unless cheaper processes are developed for such conversions. In other words, present conversion processes produce the high octanes at too high a cost for use in blending with motor fuels in the postwar period; hence, a sharp increase

H. W. Harts, Warren Petroleum Corp.; R. G. Atkinson, Shamrock Oil & Gas Corp., and B. R. Carney, Shell Oil Co., Inc., are among members of the question screening committee, assisting in the "Information Please" program



in such processing can only develop by reducing cost in the production of the finished converted materials."

Question 5.—Can L.P.G. producing plants be provided with a more uniform summer and winter load in those areas where there now exists an important house-heating demand by means of the following: (1) Increased storage (at plants, at distribution points, at consumers); (2) increased summer loads; (3) changes in composition of products; (4) higher working pressure storage and transportation equipment, and (5) reduction of standby loads?

Answer 5.—(1) Opinion is unanimous that more storage throughout the industry is desirable, particularly in those areas where large house-heating demands prevail. Where this storage should be installed varies somewhat with each company's principal transportation methods although it appears that the most important assistance can be rendered by additional quantities of storage installed at distribution points from which the fuel is directly distributed to consumers.

2. Unanimous opinion prevails as to the desirability of increasing summer loads. It should be pointed out that at the present time in the southern states the ratio between summer and winter load is considerably higher under conditions which almost completely restrict new installations. These installations generally made during the warmer months formerly provided a very sizable demand. This demand is now nonexistent and the extreme ratio between summer and winter load is presently exaggerated.

3. Changes in composition appear to be desirable, particularly as to the use of higher propane content of butane-propane mixtures, some of which is currently being done.

4. All are agreed that higher working pressure storage and transportation equipment is desirable, particularly in view of increased flexibility and possible future availability of higher vapor pressure mixtures.

5. All opinions expressed on this question reflect the desirability to reduce standby loads, since practically all of them prevail at the same time as other peak demand. This problem is summarized fairly well by one comment, which we quote below:

"Liquefied petroleum gas has played an important role in providing standby fuel for many large utility and industrial operations normally supplied with natural gas, and if these installations were so managed as to be filled only during the summer months, such standby demands would present no troublesome problems. However, many of them have made demands upon our industry during the peak winter months, creating an almost impossible situation to handle without diverting products already needed by domestic year-around industrial and utility users, and to the extent in some cases of actually affecting the demands of the 100-octane and synthetic-rubber programs. It is evident that any additional standby installations should be definitely discouraged, since they place upon production and transportation facilities another peak which, in the coming winter, appears to be one of the industry's most pressing problems."

From the information submitted above the following general conclusions are indicated:

1. Supplies of L.P.G. for fuel purposes will be adequate for those requirements where propane or high propane content mixtures may be used, but that for the duration of the war, the supply of butane and low propane content mixtures for fuel may be inadequate, especially during the coming winter. Postwar supplies of these products will be ample.

2. Little change in the relative value of propane and butane can be expected by the producer while government price controls prevail. Subsequent to such a time, opinion indicates that butane may have greater relative value to the producer than propane.

3. Except for possible changes in rail rates on L.P.G., it is not expected that costs or methods of transportation will change materially during the war. Postwar opinion is divided as to increase or decrease in costs.

4. Government restrictions will prevent increase in domestic demand for these products until some major change in the war program occurs, but it is expected that domestic sales in the postwar period will have a marked increase. Postwar industrial uses will probably be influenced to a considerable extent by new distribution of natural gas to large industrial centers. Increased use of these fuels for internal-combustion engines will probably be confined to highly specialized applications. Utility uses will also be influenced by natural-gas distribution.

The use of L.P.G. for the manufacture of chemicals will no doubt increase in the postwar period with the possibilities that butane will be in greater demand than propane.

5. The type of postwar motor fuel, the availability and price of crude oil, new refinery processes and many other factors will have an important bearing on the volumes of butane and propane supplied to a large variety of markets.

Survey of Natural-Gasoline Plants

ARKANSAS

Company, plant and county—	Approx. dly. liquid cap. (gal.)
Arkansas Fuel Oil Co., Columbia, Columbia	75,000
Arkla Oil Co., Capps, Miller	40,000
Lion Oil Refining Co.,† Schuler, Union	23,000
Magnolia Petroleum Co., Kenova, Union	27,000
Querbes Oil Co., Helwig, Union	4,000
Sam Sklar, trustee, Armstrong, Union	2,000
Sam Sklar, trustee, Louann, Ouchita	3,500
Sam Sklar, trustee, Pratt, Union	4,000
Sam Sklar, trustee, Rainbow, Union	2,500
Shell Oil Co., Inc., Magnolia, Columbia	30,000
McKamie Gas Cleaning Co., McKamie, Lafayette	25,000
Barnsdall Oil Co.,* Midway, Miller	17,000
Total	252,500

*Under construction.
†Schuler Unit gasoline plant.

CALIFORNIA

Bankline Oil Co., Long Beach, Los Angeles	20,000
Belridge Oil Co., North Belridge, Kern	75,000
Belridge Oil Co., North Belridge, Kern	75,000
Brea Canyon Oil Co., Brea-Olinda, Orange	14,000
Coline Gasoline Co., Rincon, Ventura	15,000
Coline Gasoline Co., Torrance, Los Angeles	25,000
Cowan Oil & Refining Co., Rosecrans, Los Angeles	20,000
Del Valle Gasoline Co.,* Del Valle, Los Angeles	20,000
Field, O. C., Gasoline Corp., Huntington Beach, Orange	70,000
General Petroleum Corp., Brea-Olinda, Orange	20,000
General Petroleum Corp., Rosecrans-Athens, Los Angeles	40,000
General Petroleum Corp., Santa Fe Springs, Los Angeles	55,000
General Petroleum Corp., Wilmington, Los Angeles	60,000
General Petroleum Corp., Ventura, Ventura	40,000
Honolulu Oil Corp., Buena Vista Hills, Kern	30,000
Inglewood Gasoline Corp., Inglewood, Los Angeles	6,000
Inglewood Gasoline Corp., Potrero, Los Angeles	15,000
Lomita Gasoline Co., Long Beach 1, Los Angeles	85,000
Lomita Gasoline Co., Long Beach 4, Los Angeles	30,000
The Norwalk Co., Midway-Sunset, Kern	6,000
The Norwalk Co., Santa Fe Springs, Los Angeles	20,000
Rice Ranch Oil Co., Santa Maria, Santa Barbara	3,200
Richfield Oil Corp.,* Coles Levee, Kern	32,000
Richfield Oil Corp., Long Beach, Los Angeles	25,000
Shanley Oil & Gas Co., Torrance, Los Angeles	.....
Shell Oil Co., Inc., Brea-Olinda, Orange	20,000
Shell Oil Co., Inc., Capitan, Santa Barbara	5,000
Shell Oil Co., Inc., Dominguez, Los Angeles	25,000
Shell Oil Co., Inc., Long Beach, Los Angeles	60,000
Shell Oil Co., Inc., Ten Section, Kern	35,000
Shell Oil Co., Inc., Santa Maria, Santa Barbara	2,500
Shell Oil Co., Inc.,* Ventura, Ventura	100,000
Signal Oil & Gas Co., Elwood 10, Santa Barbara	10,000
Signal Oil & Gas Co., Huntington Beach 11, Orange	27,000
Signal Oil & Gas Co., Long Beach 2, Los Angeles	30,000
Signal Oil & Gas Co., Long Beach 6, Los Angeles	15,000
Standard Oil Co. of California, Coalinga 19-B, Fresno	10,000
Standard Oil Co. of California, Coles Levee, Kern	12,000
Standard Oil Co. of California,* Greeley, Kern	20,000
Standard Oil Co. of California, Murphy-Coyote, Los Angeles and Orange	40,000
Standard Oil Co. of California, Huntington Beach 4, Orange	35,000
Standard Oil Co. of California, Inglewood, Los Angeles	30,000
Standard Oil Co. of California, Kettleman Hills 2-P, Kings and Fresno	150,000
Standard Oil Co. of California, Kettleman Hills 11-P, Kings and Fresno	65,000
Standard Oil Co. of California, Kettleman Hills 3-P, Kings and Fresno	120,000
Standard Oil Co. of California, Kettleman Hills 33-J, Kings and Fresno	100,000
Standard Oil Co. of California, Lost Hills, Kern	4,000
Standard Oil Co. of California, Taft 1-C, Kern	15,000
Standard Oil Co. of California, Taft 7-D, Kern	17,500
Standard Oil Co. of California, Taft 31-E, Kern	10,000
Standard Oil Co. of California, Mount View 32-Z, Kern	12,000
Standard Oil Co. of California, Santa Fe Springs, Los Angeles	40,000
Standard Oil Co. of California, Torrance, Los Angeles	12,000
Standard Oil Co. of California, Seal Beach, Orange	25,000
Superior Oil Co., Kettleman Hills, Kings and Fresno	100,000
Superior Oil Co., Rio Bravo, Kern	16,000
The Texas Co., Montebello, Los Angeles	40,000
The Texas Co., Santa Fe Springs, Los Angeles	50,000
The Texas Co., Shiells Canyon, Ventura	35,000
The Texas Co., Long Beach, Los Angeles	75,000
Union Oil Co., Brea-Olinda, Orange	22,500
Union Oil Co., Dominguez, Los Angeles	69,000

CALIFORNIA (Continued)

Company, plant and county—	Approx. dly. liquid cap. (gal.)
Union Oil Co., Kettleman Hills, Kings and Fresno	30,000
Union Oil Co., Playa del Rey, Los Angeles	30,000
Union Oil Co., Rio Bravo, Kern	15,000
Union Oil Co., Rosecrans, Los Angeles	27,000
Union Oil Co., Santa Fe Springs, Los Angeles	70,000
Union Oil Co., Orcutt, Santa Barbara	15,000
Union Oil Co., Santa Maria, Santa Barbara	20,000
Union Oil Co., Richfield, Orange	10,000
U. S. Navy Petroleum Reserve, Elk Hills, Kern	5,000
Universal Consolidated Oil Co., Rosecrans, Los Angeles	5,000
West Coast Refining Co., Richfield, Orange	50,000
Westates Petroleum Corp., Coalinga, Fresno	300
West Rosecrans Gasoline Co., Rosecrans, Los Angeles	5,000
Western States Gasoline Co., Kettleman Hills, Kings and Fresno	160,000
Western States Gasoline Co., San Miguelito, Ventura	15,000
Wilmington Gasoline Co., Wilmington, Los Angeles	30,000
Tide Water Associated Oil Co.,* Ventura, Ventura	80,000
Total	2,823,000

*Additions under construction.

COLORADO

Mountain States Oil Corp., Trinidad, 3-33s-62w	6,000

ILLINOIS

Arkansas Fuel Oil Co., Illinois, Crawford	500
Brenneman & MacDonnell, Condry, Crawford	1,000
Carter Oil Co., Loudon, Fayette	60,000
Sunflower Petroleum Products Co., Benton, Franklin	25,000
Sunflower Petroleum Products Co.,* Johnsonville, Wayne	5,000
Sunflower Petroleum Products Co., Salem, Marion	100,000
The Texas Co., Hoodville, Hamilton	90,000
The Texas Co., Salem, Marion	190,000
Warren Petroleum Corp., Crossville 23, White	90,000
Warren Petroleum Corp., Salem 21, Marion	100,000
Miscellaneous†	6,400
Total	667,900

*Under construction.
†Includes 17 plants in Crawford County operated by Cheuvront & Brown, Kewanee Oil Co. and Brenneman & MacDonnell as vacuum plants.

KANSAS

Barnsdall Oil Co., Rainbow Bend, Sumner	8,000
Cities Service Oil Co., Wichita, Sedgwick	25,000
Cities Service Oil Co., Burrton and Stone, Reno	60,000
Cities Service Oil Co., Madison, Greenwood	3,000
Continental Oil Co., No. 9, Cowley	25,000
Edwards Gasoline Co.,* Zenith, Stafford	.....
Flynn Oil Co., Otis, Rush	3,000
Kansas Power & Light Co., Medicine Lodge, Barber	10,000
Kansas Power & Light Co., McPherson, McPherson	10,000
Northern Natural Gas Co., Hugoton, Stevens	35,000
Panhandle Eastern Pipe Line Co., Liberal, Seward	100,000
Skelly Oil Co., Cunningham, Kingman	50,000
The Texas Co., Atlanta, Cowley	8,000
Total	337,000

*Under construction.

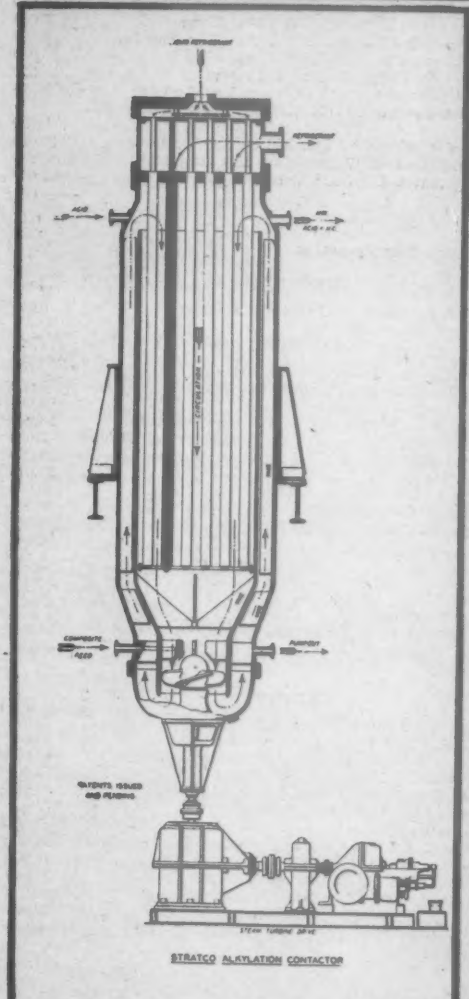
KENTUCKY

Ashland Oil & Refining Co., Fixer, Lee	4,000
Kentucky-West Virginia Gas Co., Dwale, Floyd	5,000
Virginian Gasoline & Oil Co., Leach, Boyd	40,000
Virginian Gasoline & Oil Co., Warfield, Martin	17,000
Total	66,000

LOUISIANA

Anchor Gasoline Corp., Eola, Avoyelles	20,000
Arkansas Fuel Oil Co., Langston, Claiborne	5,000
Arkansas Fuel Oil Co., Shreveport, Caddo	15,000
Arkansas Fuel Oil Co., Bisteneau, Bienville	10,000
Arkansas Fuel Oil Co., Rodessa, Caddo	15,000
Arkansas Fuel Oil Co., Sligo, Bossier	15,000
Arkansas Fuel Oil Co., Simsboro, Lincoln	10,000
Carter Oil Co., Langston, Claiborne	5,000
Carter Oil Co., Stiles, Caddo	5,000
Claiborne Gasoline Co., Lisbon, Claiborne	60,000
Coltexo Corp., Rodessa, Caddo	40,000

STRATCO ALKYLATE



STRATCO ALKYLATION CONTACTOR

Higher Yield
Higher Octane

Result:

MORE FIGHTING FUEL

STRATFORD ENGINEERING CORPORATION

PETROLEUM REFINING ENGINEERS

DIERKS BLDG. KANSAS CITY, MO.

LOUISIANA (Continued)

Company, plant and county—	Approx. dly. liquid cap. (gal.)
Continental Oil Co., Gillis, Calcasieu	20,000
Continental Oil Co., Tepetate, Jefferson Davis	20,000
Continental Oil Co., Ville Platte, Evangeline	100,000
Glen Rose Gasoline Co., Rodessa, Caddo	20,000
Great National Oil Corp., Ida, Caddo	35,000
Gulf Refining Co., Homer, Claiborne	5,000
Gulf Refining Co., Mooringsport, Caddo	2,000
Haynesville Operators,* Haynesville, Claiborne	30,000
Ohio Oil Co., Haynesville, Claiborne	2,000
Ohio Oil Co., Hodges, Webster	4,500
Shell Oil Co., Inc., Iowa, Calcasieu	12,000
Skelly Oil Co., Rodessa, Caddo	6,000
Stanolind Oil & Gas Co., Gilliam, Caddo	3,000
The Texas Co., Lafitte, Jefferson	10,000
United Gas Pipe Line Co., Cotton Valley, Webster	15,000
United Gas Pipe Line Co., Koran, Bossier	25,000
United Gas Pipe Line Co., Rodessa, Caddo	50,000
United Gas Pipe Line Co., Sugar Creek, Claiborne	18,000
Total	586,500

*Under construction.

MICHIGAN

Otha Grimes, Mount Pleasant, Isabella	5,000
West Michigan Consumers, Reed City, Osceola	5,000
Total	10,000

MONTANA

Glacier Production Co., Cut Bank, Glacier	25,000

NEW MEXICO

El Paso Natural Gas Co., Jal 1, Lea	60,000
El Paso Natural Gas Co., Jal 2, Lea	90,000
Loco Hills Pressure Maint. Co.,* Loco Hills, Eddy	10,000
Maljamar Cooperative, Artesia, Eddy	13,000
Phillips Petroleum Co.,* Eunice, Lea	100,000
Phillips Petroleum Co., Lee, Lea	37,000
Phillips Petroleum Co., Hobbs, Lea	50,000
Skelly Oil Co., Eunice, Lea	30,000
Warren Petroleum Corp., Monument, Lea	50,000
Total	440,000

*Addition under construction.

OHIO

East Ohio Gas Co., Doylestown	5,000
East Ohio Gas Co., Highland Heights	3,500
Preston Oil Co., Elk, Noble County	2,000
Preston Oil Co., Homer, Licking County	15,000
Preston Oil Co., Pavonia, Richland County	10,000
Preston Oil Co., Sugar Grove, Fairfield County	9,000
Preston Oil Co., York, Medina County	5,000
River Gas Co., Ludlow, Monroe	1,400
Total	52,100

OKLAHOMA

Barksdale Co., Barksdale, Hughes	500
Barnsdall Oil Co., Earlsboro, Pottawatomie	40,000
Barnsdall Oil Co., Flat Rock, Tulsa	5,000
Barnsdall Oil Co., Avant, Osage	3,000
Bartlett Gasoline Co., Butler, Custer	15,000
Carter Oil Co., Grisso, Seminole	75,000
Carter Oil Co., Fitts, Pontotoc	50,000
Carter Oil Co., Keokuk, Seminole	12,000
Carter Oil Co., Dunn, Seminole	12,000
Cimarron Gasoline Corp.,† Guthrie, Logan	10,000
Cimarron Gasoline Corp., Coyle, Logan	15,000
Cities Service Oil Co., James-Lacey, Seminole	15,000
Cities Service Oil Co., Bodine, Oklahoma	60,000
Cities Service Oil Co., Konawa, Seminole	15,000
Cities Service Oil Co., Asher, Pottawatonie	10,000
Cities Service Oil Co., Tallant, Osage	20,000
Cities Service Oil Co., Fish-Sasakwa, Seminole	15,000
H. B. Caldren, Barnsdall	1,000
Continental Oil Co., Plant 31, Noble	20,000
J. B. Crosbie, Inc., Fittstown, Pontotoc	25,000
Deep Rock Oil Corp., Hawk, Payne	1,000
Devonian Oil Co., Kellyville, Creek	20,000
Eason Oil Co., Plant 3, Logan	22,000
Frame Natural Gas Co., Plant 1, Pawnee	3,000
Frame Natural Gas Co., Plant 2, Pawnee	1,500
Chas. and Otha Grimes, Weleetka, Okfuskee	5,000
Chas. and Otha Grimes, Okemah, Okfuskee	3,000
Otha H. Grimes, Wetumka, Hughes	3,500
Otha H. Grimes,* Pauls Valley, Garvin	17,000
Otha Grimes and Roy Neal, Drumright, Creek	5,000
Gulf Oil Corp., Boston, Osage	1,500
Gulf Oil Corp., Burbank, Osage	10,000
Gulf Oil Corp., Kiefer, Creek	20,000

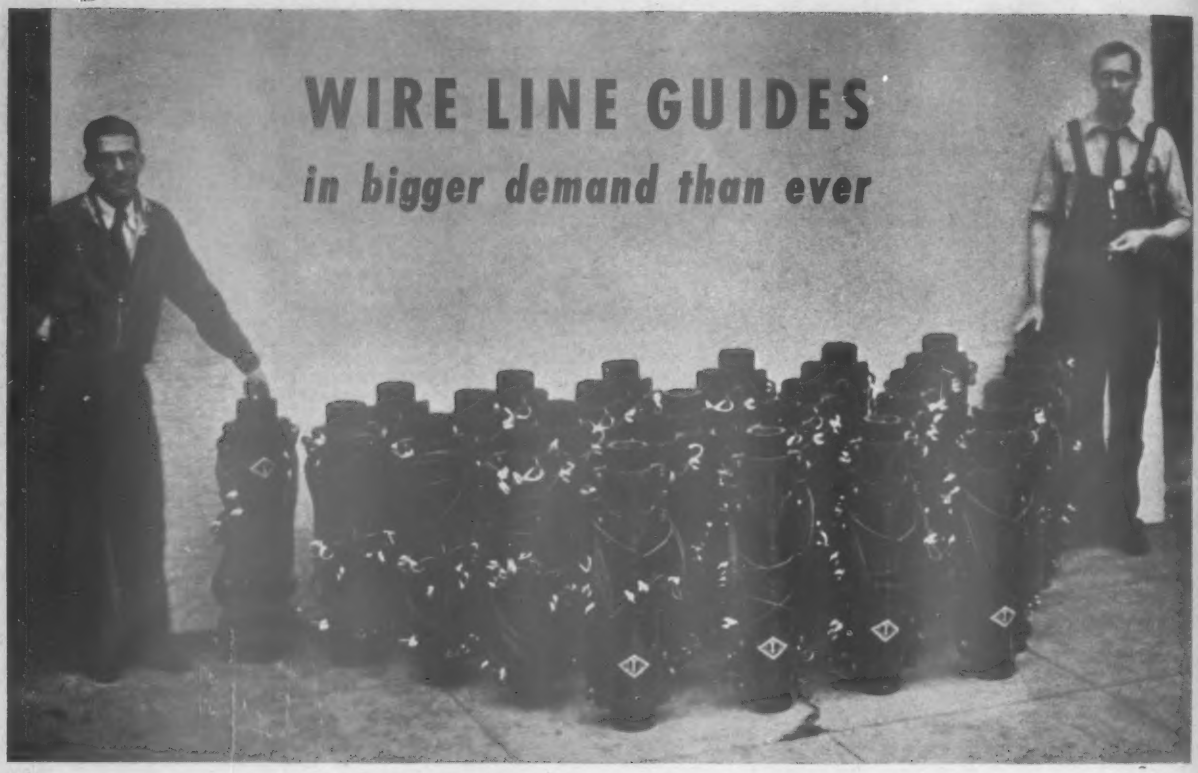
OKLAHOMA (Continued)

Company, plant and county—	Approx. dly. liquid cap. (gal.)
Gulf Oil Corp., Little River, Seminole	10,000
Gulf Oil Corp., Mission, Seminole	25,000
Johnson Oil Refining Co., Cleveland, Pawnee	500
Keener Oil & Gas Co.,† Bartlett, Custer	18,000
L. G. Lessig, Plant 1, Creek	500
Lone Star Gas Co., Hollis, Harmon	15,000
Magnolia Petroleum Co., Davenport, Lincoln	3,500
Magnolia Petroleum Co., Graham, Carter	5,000
Magnolia Petroleum Co., Oilton, Creek	10,000
Magnolia Petroleum Co., Stonewall, Pontotoc	15,000
Magnolia Petroleum Co., St. Louis, Pottawatomie	13,000
W. C. McBride, Avant, Osage	500
Mid-Continent Petroleum Corp., Leonard 9, Tulsa	1,000
Mid-Continent Petroleum Corp., Sawyer 3, Creek	15,000
Mid-Continent Petroleum Corp., Stillwater 18, Payne	10,000
Mid-Continent Petroleum Corp., Stone Bluff 4, Wagoner	1,000
Mid-Continent Petroleum Corp., Cromwell 7, Seminole	25,000
Neal Gasoline Co., Osage, Pawnee	4,000
Peppers Gasoline Co., Plant 1, Oklahoma	20,000
Phillips Petroleum Co., Reserve, Osage	35,000
Phillips Petroleum Co., Dill, Okfuskee	25,000
Phillips Petroleum Co., Wetumka, Hughes	20,000
Phillips Petroleum Co., Oklahoma City, Oklahoma	150,000
Phillips Petroleum Co., 11-11, Okfuskee	10,000
Phillips Petroleum Co., Wewoka, Seminole	30,000
Phillips Petroleum Co., Edmond, Oklahoma	40,000
Phillips Petroleum Co., Denoya, Osage	45,000
Pioneer Corp., Plant 1, Tulsa	2,000
M. F. Powers, Depew, Creek	3,000
Pure Oil Co., Plant 15, Seminole	20,000
Pure Oil Co., Drumright 1, Creek	10,000
Pure Oil Co., Berryhill Vacuum, Creek	5,000
Pure Oil Co., Poloke Vacuum, Creek	7,000
Reed & Swab, Wewoka, Seminole	3,500
Shell Oil Co., Inc., Osage, Osage	10,000
Shell Oil Co., Inc., E. Cromwell, Okfuskee	10,000
Shell Oil Co., Inc., Braman, Kay	6,000
Shell Oil Co., Inc., Dillard, Carter	16,000
Shell Oil Co., Inc., Lucien, Noble	36,000
Shell Oil Co., Inc., Barco, Carter	10,000
Shell Oil Co., Inc., Tonkawa, Noble	10,000
Shell Oil Co., Inc., E. Stroud, Lincoln	5,000
Sinclair Prairie Oil Co., Seminole 12, Seminole	50,000
Sinclair Prairie Oil Co., Lima 13, Seminole	130,000
Sinclair Prairie Oil Co., St. Louis 14, Pottawatomie	35,000
Sinclair Prairie Oil Co., Drumright 2, Creek	25,000
Sinclair Prairie Oil Co., Shamrock 3, Creek	16,000
Sinclair Prairie Oil Co., Covington 6, Garfield	15,000
Skelly Oil Co., Fairfax, Osage	70,000
Skelly Oil Co., Naphtha, Osage	50,000
Skelly Oil Co.,† Lyman, Osage	50,000
The Texas Co., Blackbird, Osage	4,000
The Texas Co., Davenport, Lincoln	12,000
The Texas Co., Moore, Creek	13,000
Tide Water Associated Oil Co., Drumright, Creek	1,000
Victor Gasoline Co., Bristow 3, Creek	4,000
Victor Gasoline Co., Stroud 12, Lincoln	2,500
Warren Petroleum Corp., Graham 8, Carter	15,000
Warren Petroleum Corp.,† Madill 22, Marshall	30,000
Warren Petroleum Corp., Maud 14, Seminole	30,000
Rosa B. Wright, Kellyville, Creek	5,000
Total	1,780,000

*Under construction.
†Addition under construction.

PENNSYLVANIA

Alum Rock Gas Co., Port Allegany, Fern	500
Bayliss & Bayliss, Titusville	10,000
Clinger Oil & Gas Co., Tidioute, Fagundus	1,000
Clinger Oil & Gas Co., Tidioute, Hastings	1,000
Cook Oil Lease, Mayburg	1,500
Crawford & Gregory, Emlenton, Fryburg	500
Dempseytown Gas Co., Port Allegany, Clarion County	1,000
Ellenburger, W. J., & Sons, Karns City	300
Elliott Brothers, Chicora	500
Equitable Gas Co., Clarksburg, Washington Co.	3,000
Equitable Gas Co., Rogersville, Green County	10,000
John J. Harvey, estate, Titusville, Pleasantville	500
Haskell, Roth & Bayliss, Tidioute, Warren County	10,000
Hickey & Russell, Henry's Mill	300
Hope Const. & Refining Co., Brave, Appalachian	25,000
Hope Const. & Refining Co., Imperial, Appalachian	3,000
Jennings, E. H., Bros. Co., Pittsburgh, Oakdale (3 plants)	1,500
Manufacturers Light & Heat Co., W. Finley	5,000
Manufacturers Light & Heat Co., Majorsville, Washington	10,000
Mars Co., Lewis Run, McKean	6,500
Mars Co., Pinegrove, Venango	4,000
Mars Co., Van, Venango	7,500
Pennsylvania Oil Co., Sheffield, Warren	10,000
Red Brush Oil Co., Tidioute, near Tionesta	300
Sloan & Zook Co., Kane	1,000
South Penn Oil Co., Pittsburgh, President	500



Stabilize wire lines
Insure perfect spooling
Obtain proper lubrication
Prevent rapid line wear
Permit faster reeling

TO get the fullest life from wire lines, Drillers are demanding Patterson-Ballagh Wire Line Guides. The demand is growing daily. These Guides perform two vital functions. They increase the life of the line anywhere from 10% to 50%, and they help speed up drilling. Lines can be run faster. The wobble is dampered. Lashing of the line from crown to drum is eliminated. These guides keep the line running true and maintain perfect spooling. Don't deny your crew this vital aid.

See Composite Catalog

PATTERSON-BALLAGH
Los Angeles 1 • Houston 10 • New York City 6

PATTERSON-BALLAGH WIRE LINE GUIDES

PENNSYLVANIA (Continued) Company, plant and county—	Approx. dly. liquid cap. (gal.)
South Heights	550
Bradford	550
New Freeport	1,000
Pleasantville	300
Porcupine	650
Sturgeon	1,500
Tiona	450
Henry's Mill	300
Noblestown (2)	1,725
Surety Oil Co., Titusville	1,000
Warner-Caldwell Oil Co., Titusville	1,000
Miscellaneous*	2,820
Total	125,845

*Covers 21 plants each with daily capacity of 200 gal. and less.

TEXAS Company, plant and county—	Approx. dly. liquid cap. (gal.)
District 2	
Clymore Co., Inc., Refugio, Refugio	20,000
Humble Oil & Refining Co., Heyser, Calhoun	10,000
United Gas Pipe Line Co., Refugio, Refugio	10,000
District 3	
American Republics Corp.,† Joe's Lake, Tyler	24,000
Danciger Oil & Refining Co., Pledger, Matagorda	40,000
Del Ray Petroleum Co., Hardin, Liberty	15,000
B. & W. Gasoline Co.,* Cleveland, Liberty	7,000
Hamman Oil & Refining Co., Hamman, Matagorda	13,000
Humble Oil & Refining Co., Conroe, Montgomery	20,000
Humble Oil & Refining Co.,† Tomball, Harris	50,000
Humble Oil & Refining Co., Dickinson, Galveston	11,000
Midland Gasoline Co., Conroe, Montgomery	30,000
Warren Petroleum Corp., Fairbanks, Harris	25,000
District 4	
Gulf States Recycling Co., San Salvador, Hidalgo	6,000
Humble Oil & Refining Co., Flour Bluff, Nueces	14,000
Sinclair Prairie Oil Co., East White Point, San Patricio	10,000
Smith Brothers Refinery Co., Inc., Welder, San Patricio	15,000
Southern Minerals Corp., Saxet, Nueces	50,000
Stanolind Oil & Gas Co.,† Luby, Nueces	50,000
Union Producing Co., Agua Dulce, Nueces	15,000
Districts 5 and 6	
Adams & Lyles, Boggey Creek, Anderson	3,000
Arkansas Fuel Oil Co., Waskom, Harrison	50,000
Arkansas Fuel Oil Co., East Texas, Gregg	65,000
Arkansas Fuel Oil Co., Smithland, Marion	10,000
Arkansas Fuel Oil Co., Jefferson, Jefferson	30,000
General American Pipe Line Co., Gladewater, Gregg	30,000
Gregg-Tex Gasoline Corp., Gregg-Tex, Gregg	100,000
Gulf Oil Corp., Cashen, Rusk	25,000
Hanlon Gasoline Corp., Gladewater, Gregg	100,000
Hercules Gasoline Co., Inc., Hercules, Gregg	90,000
Humble Oil & Refining Co., American, Gregg	40,000
Humble Oil & Refining Co., Kilgore, Gregg	45,000
Humble Oil & Refining Co., London, Rusk	100,000
Lisbon Gasoline Co., East Texas, Rusk	50,000
Lone Star Gas Co.,† Trinidad, Henderson	30,000
Mid-Co Gasoline Co., Cayuga, Henderson	12,000
Nine Oaks, Gladewater, Gregg	700
Parade Gasoline Co., Giles, Rusk	125,000
P. H. Pewitt, Joaquin, Shelby	2,000
Phillips Petroleum Co., Lodi, Cass	40,000
Pure Oil Co., Van, Van Zandt	40,000
Sabine Valley Gasoline Co., Kilgore, Gregg	90,000
Sinclair Prairie Oil Co.,† Plant 18, Gregg	100,000
Sinclair Prairie Oil Co.,† Plant 19, Smith	80,000
United Gas Pipe Line Co., Latex, Panola	2,000
Arkansas Fuel Gas Co.,* Carthage, Panola	10,000
Warren Petroleum Corp., Hawkins, Wood	52,000
District 7	
Consolidated Gasoline Co., Martin, Eastland	4,000
Desdemona Gasoline Co., Desdemona, Comanche	3,000
Hanlon Gasoline Co., Breckenridge, Stephens	40,000
Lone Star Producing Co., Ranger, Eastland	140,000
Lone Star Gas Co., Gordon, Palo Pinto	20,000
Lone Star Producing Co., Brooks, Stephens	40,000
Lone Star Gas Co., Pueblo, Eastland	10,000
Lone Star Gas Co., Sipe Springs, Eastland	1,000
Magnolia Petroleum Co., Desdemona, Eastland	5,000
Magnolia Petroleum Co., Olden, Eastland	8,000
Phillips Petroleum Co., Eliasville, Stephens	12,000
Phillips Petroleum Co., Frankell, Stephens	8,500
Phillips Petroleum Co., Ibex, Shackelford	12,000
Phillips Petroleum Co., Pioneer, Eastland	15,000
Roeser & Pendleton, Inc., Cook, Shackelford	6,000
Roeser & Pendleton, Inc., Bluff Creek, Shackelford	2,000
Rudco Oil & Gas Co., Desdemona, Eastland	5,000
Rudco Oil & Gas Co., Rising Star, Brown	5,000
Texas Pacific Coal & Oil Co., Plant 2, Eastland	10,000
Texas Pacific Coal & Oil Co., Plant 3, Stephens	16,000
Texas Pacific Coal & Oil Co., Plant 4, Stephens	10,000
Districts 7-C and 8	
Barnsdall Oil Co., Odessa, Ector	25,000
Big Lake Oil Co., Texon, Reagan	10,000
Cabot Carbon Co., Estes, Ward	35,000

TEXAS (Continued) Company, plant and county—	Approx. dly. liquid cap. (gal.)
Cabot Carbon Co., Keystone, Winkler	15,000
Cabot Carbon Co., Walton, Winkler	25,000
Cities Service Oil Co., Odessa, Ector	20,000
Gulf Oil Corp., Monahans, Ward	25,000
Magnolia Petroleum Co., Kermit, Winkler	18,000
Phillips Petroleum Co., Goldsmith, Ector	60,000
Phillips Petroleum Co., Crane, Crane	30,000
Phillips Petroleum Co., Judkins, Ector	40,000
Phillips Petroleum Co.,* Seminole, Gaines	86,000
Shell Oil Co., Inc.,† Wasson, Yoakum	116,000
Standard Oil Co. of Texas, Ward, Ward	20,000
District 9	
Continental Oil Co., K.M.A., Wichita	60,000
Deep Oil Development Co., K.M.A., Wichita	4,000
Highlander Gasoline Co., Nocona, Montague	4,000
Magnolia Petroleum Co., Burkburnett, Wichita	4,000
Magnolia Petroleum Co., Electra, Wilbarger	4,500
Nash Gasoline Co., Peters, Young	5,000
Phillips Petroleum Co., Mankins, Wichita	35,000
Phillips Petroleum Co., South Bend, Young	9,000
Rhodes Pool Gasoline Co., Bryson, Jack	2,000
Skelly Oil Co., Burkburnett, Wichita	10,000
The Texas Co., Burkburnett, Wichita	13,000
The Texas Co., Electra, Wilbarger	19,000
The Texas Co., Johnson, Foard	6,000
Tucker Oil Co., Burkburnett, Wichita	2,000
W. T. Waggoner, estate, Rock Crossing, Wilbarger	7,000
District 10	
Canadian River Gas Co., Bivins, Moore	35,000
Cannon Gasoline Co., Amarillo, Potter	6,000
Cities Service Oil Co., Pampa, Gray	25,000
Coltexo Corp., Lefors, Gray	30,000
Columbian Gasoline Corp., Shamrock, Wheeler	12,000
Danciger Oil & Refining Co., Lefors, Gray	20,000
Hagy, Harrington & Marsh, Cargray, Carson and Gray	75,000
Henderson Trust No. 2, Sanford, Hutchinson	40,000
J. M. Huber Corp., Borger, Hutchinson	30,000
Magnolia Petroleum Co., Kingsmill, Gray	9,000
Magnolia Petroleum Co., Sunray, Moore	20,000
Phillips Petroleum Co., Bowers, Gray	50,000
Phillips Petroleum Co., Canadian, Hutchinson	60,000
Phillips Petroleum Co., Carson, Carson	20,000
Phillips Petroleum Co., Gray, Gray	100,000
Phillips Petroleum Co., Johnson, Hutchinson	50,000
Phillips Petroleum Co., Lefors, Gray	15,000
Phillips Petroleum Co., North, Gray	50,000
Phillips Petroleum Co., Pampa, Gray	60,000
Phillips Petroleum Co., Panhandle, Carson	15,000
Phillips Petroleum Co., Pantex, Hutchinson	50,000
Phillips Petroleum Co., Ray 1, Moore	10,000
Phillips Petroleum Co., Rock Creek, Hutchinson	60,000
Phillips Petroleum Co., Sanford Hutchinson	40,000
Phillips Petroleum Co., Texroy, Hutchinson	50,000
Phillips Petroleum Co., Sneed, Moore	100,000
Portland Gasoline Co., Pampa, Gray	30,000
Shamrock Oil & Gas Corp., McKee, Moore	130,000
Shell Oil Co., Inc., Bryan 2 and 17, Carson	25,000
Shell Oil Co., Inc., Pampa, Gray	12,000
Skelly Oil Co., Armstrong, Moore	15,000
Skelly Oil Co., Schafer, Carson	30,000
Skelly Oil Co., Crawford, Hutchinson	15,000
Skelly Oil Co., Kingsmill, Gray	30,000
Skelly Oil Co., Watkins, Hutchinson	15,000
Smith Bros. Refinery Co., Inc., Sitter, Wheeler	40,000
Texoma Natural Gas Co., Fritch, Hutchinson	105,000
Texoma Natural Gas Co., Stinnett, Hutchinson	25,000
West Texas Gas Co., Wilhelm, Potter	15,000
Total	4,359,700

*Under construction.
†Additional construction.

WEST VIRGINIA Company, plant and county—	Approx. dly. liquid cap. (gal.)
Carbide & Carbon Chemicals Corp., Diamond	3,000
Carbide & Carbon Chemicals Corp., Hastings	2,000
Carnegie Natural Gas Co., Hundred, Wetzel	1,000
Carnegie Natural Gas Co., Underwood, Marion	1,000
Dinsmoor & Co., St. Marys, Sugar Creek, Shawnee, Henry Camp, Bills 10-Acre, Fetty, Roby, Brush Run and Pike plants	290
Falling Rock Cannel Coal Co., Falling Rock	3,000
Hapgood, Roswell T., & Co., Cedar Grove	6,500
Henaghan & Hanlon, Inc., Sistersville, Big Knot	1,000
Burns	800
Hammee	2,000
Harrisville	500
Highland	800
Murphy	300
Nye	1,500
Rock Run	600
Hope Natural Gas Co., Bristol, Harrison	8,000
Cornwell, Harrison	14,000
Goff, Harrison	5,000
Hastings, Wetzel	60,000

WEST VIRGINIA (Continued) Company, plant and county—	Approx. dly. liquid cap. (gal.)
Kennedy, Lewis	20,000
Waverly, Wood	8,000
Jennings, E. H., Bros. Co., Pittsburgh, Pa., Jacksonburg (1)	1,500
Owens, Libby-Owens Gas Dept., South Malden	10,000
Pure Oil Co., Dawes	12,000
South Penn Oil Co., Pittsburgh, Coco	2,200
Glenville	1,100
Liverpool	1,000
Mannington	1,500
Aloy	1,400
Spencer	2,600
Walton	2,400
Yawkey	3,000
Macfarlan	2,000
Wolf Summit	2,000
Metz	1,500
Smithfield	3,000
Statler Run	2,200
Pine Grove	2,500
Clay Court House	2,200
Blue Creek (1)	4,700
Union Gasoline & Oil Corp., Moundsville, Marshall	3,000
Jane Lew, Lewis	3,000
Porters Falls, Wetzel	10,000
Virginian Gasoline & Oil Co., Charleston, Kanawha	15,000
Clendenin, Kanawha	40,000
Hubball, Lincoln	12,000
Jarretts Fords, Kanawha	1,800
Mammoth, Kanawha	2,500
Ona, Cabell	18,000
St. Albans, Kanawha	3,500
Sandyville, Jackson	20,000
Three Mile, Kanawha	3,500
Miscellaneous	4,350
Total	335,140

WYOMING	
Continental Oil Co., Lance Creek, Niobrara	120,000
Northern Utilities Co., Sand Draw, Fremont	4,500
Ohio Oil Co., Grass Creek, Hot Springs	3,500
Ohio Oil Co., Rock River, Carbon	4,000
Ohio Oil Co., Medicine Bow, Carbon	2,000
Sinclair-Wyoming Oil Co., Lost Soldier, Sweetwater	4,000
Stanolind Oil & Gas Co., Salt Creek, Natrona	70,000
Total	208,000

SURVEY OF CYCLING PLANTS

CALIFORNIA

Company, plant and county—	Approx. dly. liquid cap. (gal.)
Paloma Operators Comm., Paloma, Kern	330,000

LOUISIANA

Cotton Valley Operators Comm., Cotton Valley, Webster	500,000
Stanolind Oil & Gas Co., South Jennings, Jefferson Davis	50,000
The Texas Co.,* Erath, Vermilion	800,000
The Texas Co.,† Bateman Lake, St. Mary	50,000
The Texas Co., Lake Mongoulois, St. Martin	5,000

TEXAS

Abercrombie-Magnolia Pet. Co.,† Old Ocean, Brazoria	240,000
Agua Dulce Co., Agua Dulce, Nueces	35,000
American Liberty Oil Co., Blessing, Matagorda	40,000
American Liberty Oil Co., Grapeland, Houston	50,000
Anco Gas Corp., Long Lake, Anderson	50,000
Chicago Corp., Coastal, Nueces	100,000
Chicago Corp., Wardner, Nueces	150,000
Distillate Production Corp., North Houston, Harris	80,000
Duval Gasoline, Benavides, Duval	10,000
Francitas Gas Co., Francitas, Jackson	60,000
Gasoline Production Corp., Grapeland, Houston	50,000
Geier-Jackson Recycling Co., Grapeland, Houston	75,000
Gulf Plains Corp., Bishop, Nueces	125,000
H. M. Harrell, Bammel, Harris	40,000
Humble Oil & Refining Co.,† Katy, Waller	600,000
Hunt Oil Co., Long Lake, Anderson	50,000
O. W. Killam, Joyce Richardson, Harris	10,000
La Gloria Corp., La Gloria, Brooks	300,000
L. M. Lockhart, Banquete, Nueces	40,000
Lone Star Producing Co., Grapeland, Houston	100,000
Lone Star Producing Co., Opelika, Henderson	200,000
Lone Star Producing Co., Willow Springs, Gregg	25,000
Roeser & Pendleton, Cayuga, Henderson	5,000
Skinner & Eddy Corp., Alice, Jim Wells	35,000
Stanolind Oil & Gas Co., La Rosa, Refugio	45,000
Superior Oil Co., Lake Creek, Montgomery	300,000
Sun Oil Co., Seabreeze, Chambers	5,000
Tide Water Associated-Seaboard, Cayuga 1, Henderson	60,000
Tide Water Associated-Seaboard, Cayuga 2, Henderson	60,000
Tide Water Associated-Seaboard, Long Lake 1, Anderson	60,000
Trinity Gas Corp., Long Lake, Anderson	20,000
Shell Oil Co., Inc.,* Sheridan, Colorado	260,000
Trinity Gas-Standard of Texas,* Sejita, Duval	70,000

*Under construction. †Addition under construction.

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Louisiana's Output of Cycling Products To Be Doubled by Erath Plant

*by R. L. Keyes**

Cycling is playing an important role in the war effort furnishing raw products for 100-octane aviation gasoline and synthetic rubber. New cycling projects have consistently received high priority ratings and have been encouraged and expedited by PAW due to the high yield of vital products per ton of steel used. This paper was presented at last week's spring quarterly meeting of the Interstate Oil Compact Commission at New Orleans.

THE first cycling plants were built in Texas in 1938, and during the succeeding 2 years cycling operations were confined to that state where the success of the first projects led to the installation of a large number of plants in 1939 and 1940.

Development of cycling in Louisiana lagged behind Texas due in part to the difficulties incident to unitization and the fact that most of the state's gas-distillate reservoirs were at greater depth requiring higher pressures for gas injection.

While Louisiana did not have a cycling plant in operation until 1941, a high pressure, field-stabilization and pressure-maintenance plant was built by the Continental Oil Co. in the Tepetate oil field in 1936, about 2 years before the first cycling plants in Texas. This was the first operation of this kind and its success encouraged Continental to install a pressure-maintenance plant at Ville Platte in 1940 which is the largest high-pressure project involving pressure maintenance in the petroleum and natural-gasoline industry.

The first large cycling project involving unitization of all the gas condensate reserves of an entire field was in Louisiana. Likewise, Louisiana was the first state to enact a law providing, among other things, for the unitization of gas and gas-distillate reserves on a field wide basis. Following the adoption of this law and due in a large part to the progressive and enlightened attitude of those officials charged with the administration of this law, Louisiana has been out in front among the states in promoting conservation of gas and gas-distillate reserves through unitization and unit operation.

Basis of Operations

Cycling, sometimes referred to as recycling, is the primary recovery operation by which "condensate" commonly called "distillate" is separated or extracted from high-pressure gas and the residue gas then compressed and returned to the formation. This method of production is applicable to and necessary in reservoirs where the hydrocarbons present exist in a single vapor phase in order to maintain the formation pressure and prevent condensation and resultant loss of liquid hydrocarbons in the reservoir.

While pressure maintenance is an integral part of cycling, the term "pressure maintenance" is used also and more generally to cover operations involving oil reservoirs and it is not proposed to consider in this paper either pressure maintenance of oil horizons or the recycling of gas in secondary-recovery operations but to discuss only operations involving high-pressure gas-distillate reservoirs.

At ordinary temperatures and pressures up to 500 or 600 lb. per sq. in. in mixtures of gas and liquid vapors tend to condense with increasing pressure and this fact was utilized in the early compression natural-gasoline extraction plants. At higher pressures, however, the reverse is true and condensation takes place in increasing amounts with a reduction in pressure and this is termed retrograde condensation.

The phenomena of retrograde condensation have been known and recognized in the laboratory for nearly 70 years and some of the effects were noticed in producing gas at high pressures as early as 1930, but it is only in the last 6 years that direct application of these phenomena have been used in extracting condensate and cycling of high-pressure gas reservoirs.

It is now generally accepted by engineers and operators having experience with cycling that in most high-pressure gas-distillate zones the formation pressure is at or close to the dew point and that any material reduction of this pressure will cause liquid to condense in the formation, a large part of which will become unrecoverable. In early distillate-recovery operations where the formation pressure was permitted to decline, it was noticed that there was a gradual and steady increase in the gas-liquid ratio and this fact, finally explained by retrograde condensation, led to the adoption of pressure maintenance and cycling.

There are three main types of processing plants used in cycling. The first installation involved only simple separation, utilizing the principles of retrograde condensation to extract the condensate by reduction in pressure. The second type involves the addition of some means of cooling the gas. In the retrograde range, the amount of condensation at a given pressure increases with a decrease in temperature so extraction efficiencies were improved by installing plants involving simple separation with the addition of a refrigeration cycle to reduce the temperature of the wet gas ahead of the separator.

The third type of plant utilized high-pressure absorption to extract the condensate, and plants of this type obtain higher extraction efficiencies than either of the other two. In addition to higher efficiency, this type plant has the added advantage of requiring less compressor horsepower for injection of residue gas due to higher suction pressures. All large plants installed recently have been of the high-pressure absorption type.

Conservation

Cycling, providing as it does for maximum recovery of products from the reservoir and prevention of surface and underground waste, is the highest type of conservation. It is estimated that with a well planned efficient cycling operation, 70 per cent or better of the hydrocarbons in the reservoir can be recovered which is

(Continued on page 305)

*Assistant division manager, producing department, The Texas Co., New Orleans.

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Legal Aspects of Unitization

History, Evolution and Present Status of the Law

*by R. L. Benoit**

IN any unitization project one of the basic purposes to be achieved is the conservation of the mineral resources contained in the reservoir by prevention of waste, the recovery of additional liquid and liquefiable hydrocarbons and by the production of an increased percentage of the total oil and gas in the reservoir as compared with the lesser ultimate yield recoverable without unitization. Likewise, in most instances of a unitized operation it is necessary that the program be in strict accordance with the conservation statutes and the rules and orders of the state and federal regulatory agencies. The contract and the manner of conducting the operation ordinarily must be approved by appropriate orders of the conservation authorities issued after notice and hearing. Further, of course, in these times of war it is necessary to obtain approval of the Petroleum Administration for War for a priority rating for critical materials for the plant, compressors, engines, lines and other construction.

For these and many other reasons, unitization and the conservation laws go hand in hand and it would be impossible to write an acceptable unitization contract or to properly operate and manage any unitization project without an extensive understanding of the conservation laws.

Therefore, it is both interesting and timely in the beginning to take a look at the history, evolution and present status of those laws.

Basically, the conservation laws consist of the state and federal statutes and the rules and regulations of the state and federal administrative agencies. However, of equal importance are the decisions of the courts construing and applying the statutes and the orders and determining their constitutionality. I think it is correct to say that as a matter of fact a decision rendered by the U. S. Supreme Court in 1899 is the real origin and the actual cornerstone of all present-day conservation laws. The opinion was written by Judge White, chief justice of the court and one of the outstanding jurists in the entire history of that court. Justice White had never heard of proration or the "equitable adjustment of correlative rights." He did not know anything about bottom-hole pressures, gas-oil ratios or the vagaries of retrograde condensation, but in that opinion he pronounced a series of far-reaching legal doctrines applicable today as well as in 1899. Incidentally, and happily for the industry, the opinion in that case was the beginning of the end of the antiquated rule of capture.

*Ohio Oil Co.

Indiana Case Sets Precedent

In that Indiana case the state legislature enacted a statute in 1893 prohibiting gas or oil from any well to escape into the open air for more than 2 days. Defendant in the case drilled wells in Madison County, Indiana, producing oil and casinghead gas, and this gas was allowed to escape into the air. The State of Indiana sought an injunction restraining the defendant from wasting the gas in violation of the statute. The defendant contended it was engaged in the business of producing oil and had expended large sums of money in purchasing leases and drilling wells and that these wells were drilled for the sole purpose of producing oil; that it was without any facilities to handle the gas and that the gas was produced by the wells simultaneously with the oil and the gas was a lifting agency in the production of the oil. Defendant further contended that "no machinery or process of any kind has ever by the highest skill been defined or known to the world whereby in such a case the oil can be produced and saved without at the same time allowing such gas as is in the well to escape and therefore if the gas is shut in it will be impossible to produce any oil and thereby defendant's business, property and profits would be destroyed and that the oil was vastly more valuable than the gas. Defendant therefore prayed that the contentions of the State of Indiana be rejected and that it be allowed to continue producing the oil and blowing the gas.

Herein, the author summarizes the chief deterrents to unitization of gas-condensate fields. It is the author's extended digest of the complete paper presented this week at the annual meeting at Dallas of the Natural Gasoline Association of America. All operating practices, he pointed out, must be coordinated with state and federal conservation regulations and, at the same time, justified on an economic basis.

Thus, the issue was squarely presented as to whether or not this Indiana statute prohibiting gas waste was violative of the fourteenth amendment to the United States Constitution which provides that no person shall be deprived of his property without due process of law.

The court held that the Indiana statute was a valid exercise of the state's police power and that the statute was constitutional.

Justice White said:

"On the other hand, as to gas and oil, the surface proprietors within the gas field all have the right to reduce to possession the gas and oil beneath. They could not be absolutely deprived of this right which belongs to them without a taking of private property. But there is a coequal right in them all to take from a common source of supply the two substances which in the nature of things are united, though separate. It follows from the essence of their right and from the situation of the things as to which it can be exerted, that the use by one of his power to seek to convert a part of the common fund to actual possession may result in an undue proportion being attributed to one of the possessors of the right to the detriment of the others, or by waste by one or more to the annihilation of the rights of the remainder. Hence it is that the legislative power, from the peculiar nature of the right and the objects upon which it is to be exerted, can be manifested for the purpose of protecting all the collective owners, by them, of their privilege to reduce to possession, and to reach the like end by preventing waste.

"Now, it is doubtless true that the public has a sufficient interest in the preservation of oil and gas from waste to justify legislation upon this subject. In the disposition he may make of it (private property) he is subject

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to two limitations. He must not disregard his obligations to the public. He must not disregard his neighbor's rights. If he uses his product in such a manner as to violate any rule of public policy, or any positive provisions of the written law, he brings himself within the reach of the courts. If the use he makes of his own, or its waste, is injurious to the property or the health of others, such use or waste may be restrained, or damages recovered therefor.

"In consequence of the nature of the deposits, of their transmissibility, of their interdependence, of the rights of all and of the public at large, the state could lawfully exercise the power to regulate the right of the surface owners among themselves to seek to obtain possession, and to prevent the waste of the products in which all the surface owners within the area wherein the gas and oil were deposited, as well as the public, had an interest, because in the preservation of these substances the well being and prosperity of the entire community was largely involved."

The Ohio-Indiana case has been followed by a long line of decisions by state and federal courts, sometimes striking down statutes and orders as in the Thompson vs. Consolidated case which involved the Texas Panhandle gas field and the federal court decisions holding the earlier Railroad Commission proration orders in the East Texas field to be invalid, but in the main sustaining the statutes and orders as a reasonable exercise of the police power and reaffirming the doctrines of the Indiana case.

Refer briefly to the Stanolind-Patterson case sustaining an Oklahoma compulsory pooling statute and order on a 10-acre production unit and the Hunter case in Louisiana validating the conservation statute and a compulsory pooling and proration and well-spacing order on Logansport gas field and the Rowan and Nichols-Humble cases involving the East Texas proration orders.

Then refer briefly to the conservation statutes, as for example, Texas, Oklahoma, Louisiana, Arkansas, Michigan, New Mexico, etc. These statutes originally were more or less crude efforts to provide for conservation, but by a gradual process of education and evolution there has resulted the present-day type of law prohibiting and defining waste; prohibiting the inefficient, excessive or improper use or dissipation of reservoir energy and the driling of unnecessary wells, providing spacing rules, and regulations outlawing economic waste by producing oil or gas in excess of transportation or marketing facilities or reasonable market demand and making provisions for both voluntary and compulsory pooling and untization of entire pools or individual drilling and production units within a pool to conform to spacing pattern.

In the light of these statutes and court decisions the industry today is in a much firmer position than at any time in its history to operate fields on a unitized basis.

Importance and Benefits of Unitization

The importance and benefits of unitization are matters of common knowledge within the industry. However, an illustration would not be out of order. Cotton Valley is an outstanding example. In that field there were approximately 80 wells in Bodcaw and D sands at about 8,500 ft.; drilled generally under an 80-acre spacing rule and at a cost of some $100,000 per well representing a total investment of more than $8,000,000. The field covers about 13,000 acres, thus leaving about 80 undrilled production units. The gas-oil ratio, or rather the gas-condensate ratio, was about 14,000 to 1. The mineral products were in the gaseous phase in the reservoir. The field was classified as a gas field and the proration order allowed production of a fixed quantity of gas daily with waste prohibited and allowed the production whatever quantity of condensate the well would make in the production of its allowable gas. If each well could have produced even as much as 100 bbl. daily of oil the total field-gas production would have been about 112 million cubic feet per day. Gas waste was prohibited under the existing proration order and the available gas market was only about 20 million cubic feet per day. The two comparatively small gasoline plants in the field were wholly inadequate to process any substantial portion of the field production and there was no market for the residue. From these fields the dilemma which confronted the operators is apparent. The oil could not be produced without simultaneously producing the gas and the alternatives were first to continue drilling and enjoy the privilege of producing negligible quantities of oil and gas wholly insufficient to net more than a nominal return on the drilling investment, or second, violate the law by blowing the gas and thus wasting it and its hydrocarbon content, or third, unitize the field, build a processing and pressure-maintenance plant thus producing the distillate, recovering the liquefiable hydrocarbons from the gas and returning the gas to the formation to minimize reservoir pressure decline. The latter was done and since that time everybody has been happy, including operators, royalty owners, and the state. It has been an extremely satisfactory and gratifying operation in which all interested parties and agencies have most materially benefited.

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Conservation in Postwar Era to Change Character of Natural-Gasoline Plants

*by Paul M. Raigorodsky**

CERTAIN factors, of importance in war time, will carry over with perhaps even greater force in the postwar period and will have profound effect on the natural-gasoline industry.

Under current conditions the postwar possibilities of the natural-gasoline industry resolve into two parts, namely:

1. Postwar possibilities of natural-gasoline plants.
2. Postwar possibilities of cycling plants.

In the postwar period only a few natural-gasoline plants will be built as such. This condition will be brought about by rigid conservation measures, resulting from decreased crude reserves in the United States. The production of crude oil in the future will be from wells with greater spacing than heretofore. To effect maximum recoveries, pressure maintenance will be enforced. Natural-gasoline operations will become an integral part of the crude-oil production program and not merely a by-product recovery project. These conditions suggest that the natural-gasoline plant in the postwar period will have as its prime function the recovery of additional petroleum fractions, crude and otherwise; and under these circumstances, it should become the function of the natural-gasoline manufacturer to supply the essential additional services. Unquestionably the natural-gasoline manufacturer could offer the best possible medium for bringing together all the various interests in this new situation.

Postwar Possibilities of Cycling

The postwar period will find a great increase in the number of cycling plants. A recent check of new discoveries shows that approximately 75 per cent of new reserves are of the condensate type and of substantial magnitude. A plant to process from 100 to 300 million cubic feet of gas daily will not be unusual.

Unitization or consolidation of operation will become a term of increasing importance because the complexing phenomena of retrograde condensation requires treatment of the condensate sand as a unit. Such operations can only be effected on a practical and economic basis under a program of unitization or consolidation of leases.

The operation of cycling plants in most cases will be in the hands of those companies directly concerned with the producing operations in the field due to the close relation between the cycling and the production program. If one or more of the producers is also a transporter and refiner of petroleum, products of cycling operations through refinery channels will be available and much of the present disinclination to use condensate, natural gasoline and its derivatives will be minimized or eliminated. The dove-tailing of cycling and refinery operations will bring forcefully to the attention of the petroleum industry the value and the desirability of using field plants for the production of chemical raw materials and finished products, chief of which may become aviation fuel.

Greater Economies Possible

The use of field plants for the production of chemical raw materials and finished products will allow for greater economies in over-all operations. Current conditions have accelerated and in some cases have forced some of these developments upon the petroleum industry, but the postwar period will see ever increasing developments in this field.

Prediction that the natural-gasoline industry will occupy a different position in the postwar era is made in this forecast of future operations. A much closer relationship is anticipated between manufacture of natural gasoline and producing operations with much greater emphasis on cycling. Use of field plants in the extraction of light hydrocarbons for use in the petroleum and chemical industries is assured, the author holds, because of the difficulties encountered in transporting the volatile products. Large quantities of ethyl alcohol probably will be manufactured from natural gasoline in the postwar period.

In the postwar period the production of synthetic goods will not only continue but will increase. War-time conditions have insured the development of processes in which natural-gasoline derivatives may be reformed into chemical raw materials. The most important of these raw materials will be acetylene, ethylene, and propylene. These materials may be the starting point for the production of the super glass, Lucite and Plexiglas, superior synthetic rubbers, Vinyon synthetic fibers, Saron, and others. These synthetic products will tend to replace natural products to such extent, particularly metal materials, that the source of the raw material for their manufacture must be carefully considered. Controlled oxidation of natural gas yields aldehydes and alcohols. In addition to methanol, the postwar period should see immense quantities of ethyl alcohol manufactured from natural gas. Formaldehyde, which is of fundamental importance in the production of the majority of molded plastics, will be one of the outstanding chemical raw materials derived from natural hydrocarbons. These developments will be dependent upon the availability of large quantities of light hydrocarbons and the difficulty encountered in their transportation, owing to their physical properties, insures the use of field plants in the postwar petroleum and chemical industries.

Gas Enrichment Market

In the postwar period the natural-gasoline industry should have new and increased demands for its products in outlets to the gas industry. During this period developments in house heating and cooling, together with increased demands for distributed gas, will taxe existing systems. The manufactured gas industry of today finds itself face to face with a grave condition because large cities are rapidly nearing the capacity of their distribution systems. Constant pressure requirement, together with

*Vice President of Petroleum Engineering, Inc.

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intricate design of distribution systems, makes installation of increased capacity impossible, if at all, only with great expense. One answer to this problem which has been adopted by some leading gas companies is the conversion to higher B.t.u. gas. The manufacture of gas in excess of 550 B.t.u. per cubic foot in the absence of cold enrichment is not economical in present-day manufacturing sets. Higher B.t.u. content of manufactured gas will be obtained economically and practically by the use of natural and liquefied petroleum gas. In addition, such additives would substantially improve the quality of the resultant mixture.

The development of new processes is continuous. In addition, modern methods of chemical analysis will replace the old and cumbersome methods which made efficient plant control difficult. New processes will in some cases eliminate the necessity of separation of light hydrocarbons from gas. These conditions will have a great effect upon the natural gasoline and cycling industries in the postwar period and will result in many adjustments.

The natural gasoline industry has grown until it now is entering upon a new and outstanding phase of its relationship to the petroleum industry as a whole. To survive and grow, natural-gasoline operations must be expanded to cover fields other than that of strictly hydrocarbon recovery and separation. The natural-gasoline industry must face these facts and prepare to make the required adjustments so that the service it now renders the country in wartime will be continued in the postwar period.

Edict Repeated, "No Sweet Gas for Carbon Black"

AUSTIN.—Texas Railroad Commission last week repeated its edict that sweet natural gas may not be burned in the manufacture of carbon black by the channel process. Its pronouncement was a reply to a telegram from Thomas J. Starkie, head of the War Production Board's pigment and color unit, saying every pound of easy-processing channel black possible is needed for the war effort. The commission declared that statutory sweet gas wells owned by Smith Brothers refinery cannot legally furnish gas to the Lefors plant of Columbian Carbon Co. If it were casinghead gas, the commission said, the plant could use the gas.

Starkie recently was told here that use of sweet gas for channel carbon is illegal and that Texas has sour gas and casinghead gas available for that product.

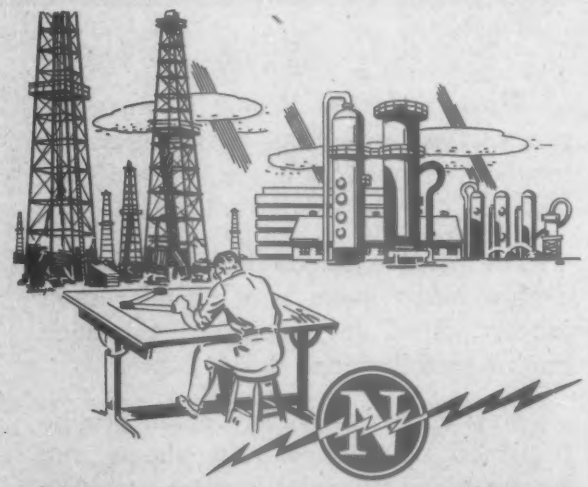
Texas Gas Allowables Are Announced by Commission

AUSTIN.—Allowable daily production of sweet natural gas for April has been set by Railroad Commission of Texas as follows in the fields named: Agua Dulce (Dabney sand), 25,000,000 cu. ft.; Rodessa, 41,212,467 cu. ft.; Carthage, 11,668,300 cu. ft. Allowable daily production of sour gas in the West Panhandle field was set at 678,440,000 cu. ft.

Seeks to Acquire Facilities Of Kentucky Pipe Line

WASHINGTON.—Federal Power Commission will hold a hearing April 13 in Terre Haute, Ind., on proceedings arising from application of Indiana Utilities Corp. for permission to acquire from Kentucky Pipe Line Co. and operate certain natural gas facilities in Harrison County, Indiana, and an application filed by Louisville Gas & Electric Co. for permission to sell and deliver natural gas for resale to Indiana Utilities Corp. at the Kentucky-Indiana State line.

FPC's order, which consolidates the proceedings, states that the facilities which Indiana Utilities Corp. proposes to acquire and operate include 40,285 ft. of 8-in. transmission lines,



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33,700 ft. of gathering lines, seven producing natural-gas wells and two natural-gas wells not now commercial producers, nine natural-gas leases, one 60-hp. gas compressor with appurtenances, and land with a building thereon, in Harrison County, Indiana, used as a compressor station.

Regulations Tightened on Liquefied Petroleum Gas

WASHINGTON. — Tighter restrictions on the use of equipment, and a prohibition against the use of liquefied petroleum gas as a motor fuel in passenger automobiles, were announced last week by Deputy Petroleum Administrator Ralph K. Davies. Action was taken to meet a threatened shortage of this product.

Davies explained that available supplies of butane and propane, the type of liquefied petroleum gas commonly used by civilians, are now needed to meet increased military requirements as well as essential industrial, commercial and civilian needs. Additional consumption, he said, would reduce the quantity of liquefied petroleum gas available to essential consumers.

The new restrictions are imposed by three measures:

1. An amendment to Limitation Order L-86, issued by the War Production Board upon PAW recommendation.

2. Issuance of two formal WPB directions (Directions 1 and 2) to the L-86 order; and,

3. A revision of Form WPB-809 on which application is made for authority to install liquefied petroleum gas equipment.

The L-86 order formerly permitted installation of certain specified liquefied petroleum gas equipment without obtaining a specific exception to the order. As newly amended, however, Order L-86 no longer allows installation of such equipment for the following uses: (1) To burn liquefied petroleum gas in an internal combustion engine such as stationary engines or motor vehicles. (2) To connect an additional gas-consuming appliance, such as a gas furnace or water heater, to existing liquefied petroleum gas systems already in use.

Direction 1 provides that tank manufacturers shall not deliver a liquefied petroleum gas tank unless the purchaser has submitted to the manufacturer the original authorization made by the WPB granting permission to install a tank. In addition, the purchaser must present the manufacturer with a purchase order certifying that the purchase is in conformity with current regulations.

Direction 2 prohibits the delivery of liquefied petroleum gas for the purpose of burning the gas as a motor fuel in passenger automobiles.

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Louisiana to Double Cycling Operations

(Continued from page 295)

more than double what would normally be recovered if the field were produced in a conventional manner without cycling. In addition the dry gas returned to the formation will be available at a later date, and it will be possible to utilize it to the best advantage and in the highest possible way. The market and use to which the gas will be put can be developed as and when desired as there is no need to produce it until it is advantageous to do so.

Careful consideration must be given to the arrangement or spacing of wells in a cycling project if maximum recovery is to be obtained. The proper location of injection and producing wells depends on the shape, size, and structure of the reservoir. This requires an accurate and detailed knowledge of the subsurface or reservoir conditions. In general, injection wells should be as far as possible from the producing wells and both injection and producing wells uniformly spaced with regard to the volume of reservoir space so that the dry gas will advance uniformly sweeping out or displacing to the producing wells a maximum of reservoir or wet gas without channeling of the dry gas and with a minimum of interference. An ideal reservoir for cycling is one consisting of a homogeneous sand with uniformly high porosity and permeability existing as a blanket over the structure and unbroken by faults.

Unitization

It should be obvious that, for efficient operation including proper spacing of wells to insure maximum recovery, a cycling project should be operated as a unit without regard to property lines. A haphazard arrangement of wells or competitive operations will only result in premature channeling of gas, bypassing of wet-gas reserves, and a loss of recoverable products. Therefore, in order to protect the correlative rights and provide for the equitable participation of all parties, some form of unitization must be obtained.

Where there are many diversified ownerships, the legal work connected with unitization is highly involved, difficult, and seemingly endless. Voluntary cooperation in a unit plan is always difficult of achievement where there are large numbers of interested parties, due to various reasons such as the lack of a true understanding of the problems involved, of the benefits to be obtained, and various items of self interest. Most oil-producing states have statutes based on conservation of oil and gas resources, regulating and controlling production including pooling of acreage in drilling units. It therefore would appear that the states clearly have the power to effect field-wide unit operation and cycling of gas condensate reservoirs based on prevention of waste and to protect the correlative rights of mineral owners. Louisiana passed such a law in 1940 and several condensate fields have since been unitized and cycling projects placed in operation under the provisions of this law.

As an example of the difficulty and inequity involved, where there is no statute that can be used to force unitization, the following is cited:

The operators in a condensate field (not in Louisiana) have been attempting for 4 years to unitize in order to build a plant to efficiently cycle the gas and recover the liquid products. All the operators, with one exception, reached an agreement in regard to unitizing the field and building a cycling plant. However, this one operator owning less than 20 per cent has successfully blocked the unitization for this period and in addition, during this time, he has produced about 15 per cent of the total field reserves through separators at the well, recovering inefficiently the distillate and selling some of the gas at no profit. There has already been a considerable decrease in formation pressure and it is estimated that in addition to inefficient recovery of liquid from the gas and waste and inferior utilization of the gas, there has been over a million barrels condensed out into the formation. During this time the wells of the other operators have been shut in with no participation on their part. It is believed that the largest single factor at present retarding adoption of large scale cycling projects is the extreme difficulty met and long time taken in unitization and it is hoped other states will follow Louisiana's lead and provide statutory help and encouragement for unit operation.

The simplest method for determining equities is on the basis of acreage and is the one widely used in the past. Allocation on this basis is fair when there is only one sand which has the same thickness over the productive area. However, where there are several sands in the unit varying in thickness and in recoverable liquid content, an entirely different basis must be used. With a knowledge of subsurface conditions and reservoir content, the reserves in place can be calculated with reasonable accuracy and provide the most equitable basis for participation.

Louisiana Cycling Operations

Cycling in Louisiana began on a commercial scale when the Cotton Valley cycling plant in the Cotton Valley field was completed and placed in operation in July 1941, processing 150,000,000 cu. ft. of gas by absorbing at 1,500 lb. and returning the residue gas to the formation after compressing to 3,200 lb. This was the first time that the entire gas-distillate reserves of a large field (nearly 15,000 acres) were unitized, and the project participated in by 25 operators and over 600 land and royalty owners was an outstanding contribution to the cause of conservation, and pointed the way to unit operation for the industry. This project is operated by the Cotton Valley Operators Committee composed of representatives of companies party to the unit.

By operation of a pilot plant in the field in 1938, it had been demonstrated that cycling was feasible and that it was possible to separate the liquid hydrocarbons from the gas at high pressure. Immediately following this a determined effort was made to sell the various operators and royalty interests on a unitized cycling project, but it was not until June 29, 1940, about 2 years later, that unitization became assured with the agreement of 80 per cent of the interested parties.

On January 28, 1941, when signatures of 92 per cent of the operators and 97 per cent of the royalty owners had been obtained, the Louisiana Department of Conservation, following a hearing issued on order effective February 1, 1941, unitizing and pooling all lands, royalties and lease interests in the reservoirs which were estimated to be productive of gas containing condensable hydrocarbons at a gas-liquid ratio in excess of 10,000 cu. ft. per barrel. The order also contained a provision for enlarging the unitized area in the event additional acreage was proved or became known to be productive. Subsequently, by hearing before and on order of the Department of Conservation, the unitized area has been enlarged eight times by the addition of acreage originally outside. There are two sands in the unit and participation is on a modified acreage basis with 75 per cent credit for acreage in one and 25 per cent credit for acreage in the other.

When operation of the Cotton Valley plant started, there were approximately 100 wells already drilled in the unitized area. However, for effective cycling, it was only necessary to utilize 35 as producing wells and 10 for injection and the balance were shut in. From these 35 producing wells, approximately three times as much condensate was recovered as had been previously withdrawn from the 100 wells and in addition, the residue gas was returned to the formation. The value of the gas returned, which was largely wasted before, alone amounted to about $40,000 a day.

At present the plant is operating to capacity with 40 producing gas-distillate wells and one high ratio

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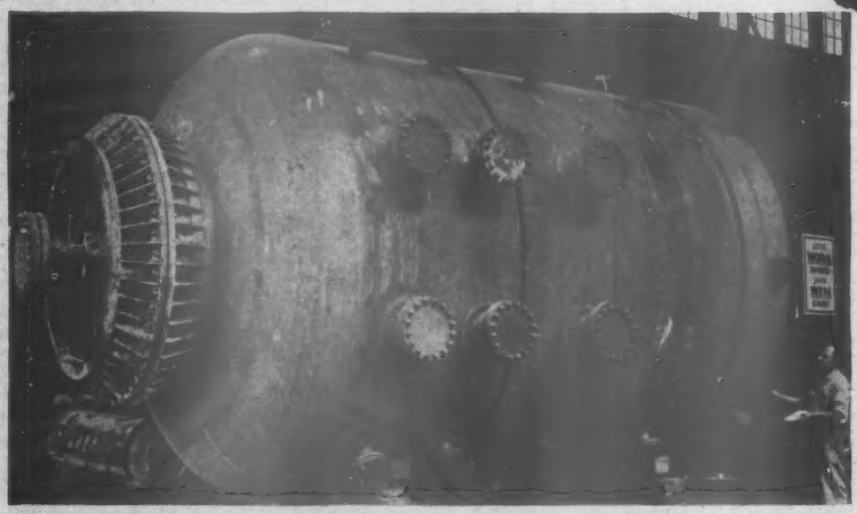

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oil well tied into the plant, 8 injection wells and 66 wells shut in, making a total of 115 wells in the unit. Liquid products recovered amount to over 11,000 bbl. a day including isobutane which goes into production of 100-octane gasoline, and since May 1943, after installing additional fractionating equipment, the plant has been separating out toluene naphtha which is used in the manufacture of explosives.

South Jennings

In December 1941 Stanolind Oil & Gas Co. started operation of a 45,000,000-cu. ft., high-pressure absorption cycling plant in the South Jennings field in Jefferson Davis Parish.

Unitization, similarly to Cotton Valley, was effected by order of the Louisiana Department of Conservation. The unit included the three proved productive gas sands or horizons known as the 8,600-ft., 8,800-ft., and 9,500-ft. sands.

While the productive limits of the three sands all lay within the unitized area of 1,920 acres, they did not coincide. The productive limits of the 8,600-ft. sand included 1,500 acres, the 8,800-ft. sand 1,350 acres, and the 9,500-ft. sand, only 540 acres. In addition the amount of condensate that could be recovered from each sand was different, making it clearly inequitable to provide for participation on an acreage basis. Consequently, allocation of production and royalty settlements were provided for on the basis of the original reserves in place under each tract. This, it is believed, is the first time unitization was effected on a reserve-in-place basis in a cycling project.

Bateman Lake

In January 1942 The Texas Co. started cycling operations in a limited section of the Bateman Lake field with a plant having a capacity of 30,000,000 cu. ft. per day. The reservoir cycled is at a depth of 10,400 ft. Absorption is carried out at a pressure of 2,000 lb. per sq. in., and a pressure of 4,500 lb. per sq. in. is required for injection. This was the first plant with an injection pressure of over 4,000 lb. and most plants operate at 3,000 lb. per sq. in. or lower. Two years of successful operation of this small plant has demonstrated that it is entirely feasible and practicable to inject at these pressures.

The field is not as yet completely defined but wells are now being drilled with that purpose in view and a contract has been let and material ordered for adding 40,000,000 cu. ft. capacity to the operation. A unitization program is being worked out with allocation of equities on a reserve in place basis.

Erath

The Erath unitization project and the Erath cycling plant now being completed and expected to commence operation this month have several unique and interesting features.

This project includes in one unit the plant, field lines, and wells including all gas and gas distillate sands below a depth of 8,000 ft.

There are 44 owners of leasehold interests and over 400 landowners and royalty owners in the unit. Participation is on the basis of reserves in place.

The cycling plant is the largest in Louisiana and has more compressor horsepower for injection than any other plant in the entire Gulf Coast and Mid-Continent area.

Cycling of zones at greater depth and consequently at higher pressures than heretofore attempted is planned.

Unitization occurred early permitting the field to be developed on a basis planned for efficient cycling.

The plant is designed to process 200,000,000 cu. ft. of wet gas per day from which it is estimated there will be recovered over 16,000 bbl. of liquid products including 3,000 bbl. of butanes and isopentane that will go directly into the manufacture of 100-octane gasoline. The wet gas will be delivered to the plant at a pressure of 2,500 lb. per sq. in. and the initial separation and absorption of the liquid condensate will be at a pressure of 1,800 to 2,000 lb. per sq. in. After compression the residue gas will be returned to the formation at pressures of 4,600 and 4,800 lb. per sq. in. This requires 16 800-hp. compressors totaling 12,800 hp.

The field has an areal extent of slightly more than 3,000 acres and in the initial operation, it is planned to cycle 4 of the 19 gas-distillate sands existing in the field. These sands are at depths of 8,700; 10,100, 10,400, and 10,800 ft. There are 29 wells, 14 of which are dual completions making 43 effective wells. Of these, 12 will be used for injection and the remaining 31 will be producing wells.

Control and administration of the unit is vested in an operating committee consisting of 6 members, 4 of whom are representatives appointed by each of the 4 large operators owning together 98 per cent of the working interest and two appointed by the remaining 40 owning 2 per cent. Voting is on the basis of interest in the unit. However, it requires the vote of at least 3 totaling 60 per cent to carry a proposition. Advising and assisting the operating committee are subcommittees dealing with the legal, engineering, geological, and accounting phases of the project.

The discovery well of the field, The Texas Co. 1 Vermilion Parish School Board, was completed April 26, 1940. During the following year, 12 wells

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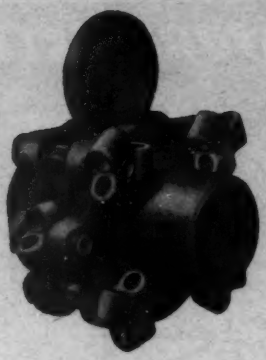

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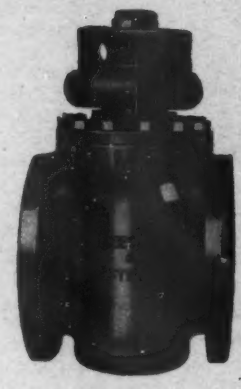

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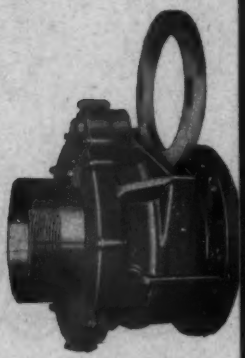
Standard Line Blind.



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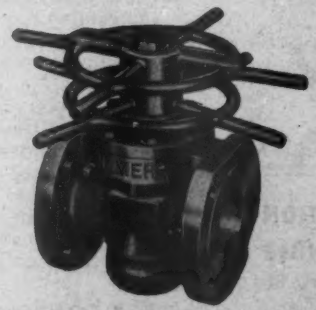

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Plants: Maywood and Elgin, Ill.

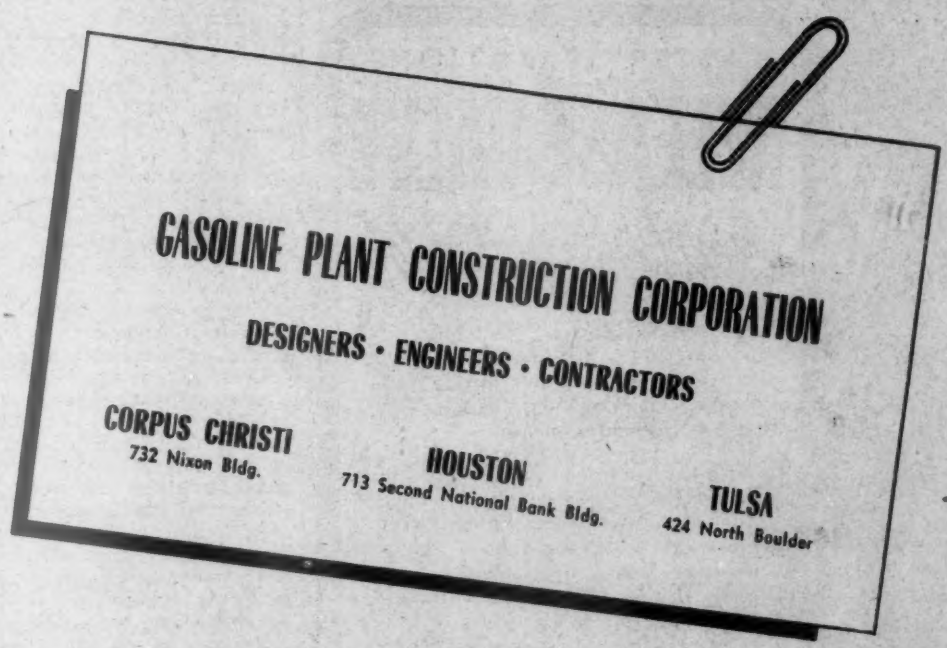
were drilled in an attempt to develop commercial oil production. Four of these wells were dry holes outlining the productive limits of the field. The other eight wells failed to find oil in commercial quantities but all had a large number of gas distillate sands. One of these wells, Phillips Petroleum Co. 1 Fitzsimmons, was drill-stem tested in 10 separate sands between depths of 9,000 and 12,000 ft., demonstrating the presence of gas and distillate in all 10, some of which were very rich in percentage of condensate liquid hydrocarbons.

By this time it was evident that efficient operation and maximum recovery would require cycling of the field. Consequently the four larger operators, The Texas Co., Phillips Petroleum Co., Tide Water Associated Oil Co., and Humble Oil & Refining Co., following several discussions in the early fall of 1941, agreed to unitize their holdings and build a cycling plant.

At a public hearing held before the Department of Conservation on January 5, 1942, testimony comprising all the available engineering and geological data was submitted by the four companies. Following this on January 27, 1942, the commission issued an order finding that cycling was feasible and necessary in the Erath field in order to obtain maximum recovery of distillate, with a minimum of waste and conservation of gas. The commission approved the drilling of two additional wells to supplement and confirm the existing geological and engineering data, but ruled that no additional wells should be drilled except and when they were shown to be necessary to cycling operations of said field.

Subsequent to January 5, 1942, an intensive and careful study of the field was made by geological and engineering committees composed of representatives from each of the four companies. In addition to drilling the 2 wells, 45 extended flow tests were made to obtain accurate gas-liquid ratios. Separator samples of gas and liquid as well as some bottomhole samples were analyzed to obtain the volumetric and phase behavior of the reservoir fluids.

At a second public hearing held on June 16, 1942, all these data together with a plan of unitization were submitted to the commission. This plan embodied in a unit operating agreement, and a royalty owners unitization agreement, provided that all equities of landowners, royalty owners, and those owning minerals or leases would be on exactly the same basis of the reserves in place under each individual tract. These equities had been calculated for each tract and were submitted at this time. The agreements further provided that, after drilling additional wells, equities would be adjusted in the light of additional information obtained on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exactly the same basis as in the original calculation.

The commission issued an order based on this hearing November 19, 1942, finding that the unitization plan as contained in the two agreements was a fair, reasonable and equitable method of unitizing, pooling, and combining separate ownerships and establishing the correlative rights of the respective owners affected. The order fixed the boundaries of the unit, adopted and approved the two agreements, and provided for the addition or inclusion of any acreage later proved to be productive.

Construction of the plant was started in November 1942, after about 6 months of preliminary design and engineering work by a committee of engineers from each company.

The drilling of the 18 additional wells was immediately started and carried out on a spacing program, the primary purpose of which was to provide for maximum cycling efficiency.

During the drilling of the Erath wells over 11,000 ft. of cores in all prospective sands and in all sections of the field were taken and these were analyzed to determine the porosity and permeability of the different productive horizons for use, together with reservoir content, in determining the reserves for equity recalculation.

During the time these wells were being drilled and almost continuously during the year following the November 1942 hearing, extensive production tests of wells and laboratory tests of well production were made. Every effort was expended to obtain a maximum amount of reservoir information to insure a fair distribution of equities to all interested parties.

On December 17, 1943, at a hearing before the commission, testimony and exhibits were presented consisting of revised contour maps and revised net sand thickness maps of the 14 remaining reservoirs, and all engineering and reservoir data accumulated since the start of development. The equity distribution to each tract revised and recalculated based on these data, was likewise submitted at this time.

The commission on December 29, 1943, issued its order approving the revised equity distribution and adjusted the boundary of the unit area to include five small additional tracts indicated by new data to be productive and confirmed the previous orders issued.

It is believed that, while there has been an unusually large and costly amount of testing, geological, and engineering work expended on this project, that it has resulted in the fairest and most equitable participation of all interested parties possible.

During 1943, the four cycling plants in Louisiana processed 92,200,000,000 cu. ft. of gas recovering 4,503,575 bbl. of liquid products and returned 64,400,000,000 cu. ft. of residue gas to the reservoirs.

These plants are currently processing 260,000,000 cu. ft. of gas and extracting 13,000 bbl. of products per day. When the Erath plant reaches capacity operation the amount of liquid products produced by cycling plants in Louisiana should be increased to about 30,000 bbl. per day. While this is a relatively small amount compared to the state's oil production of 360,000 bbl. per day, it is, however, a valuable addition which, due to the fact that a large part goes directly into products used in the war, represents a sizeable contribution.

There are a considerable number of fields in Louisiana having gas-condensate reserves and many offer good prospects for cycling operations. There are several plants already projected and others contemplated and the desirability of the products for use in 100-octane gasoline and other war products, together with the statutory assistance provided by the state for unitization, should tend to expedite their construction.

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REFINING

Aviation-Gasoline Output Is Now Nine Times Greater

HAMMOND, Ind.—Refiners of this country soon will be producing 12 times as much aviation gasoline as they did before Pearl Harbor, W. W. Vandeveer, director of District 2 of Petroleum Administration for War, told refinery workers at a Victory rally here April 7.

"Production of 100-octane gasoline today is nearly nine times the output at the time of Pearl Harbor," Vandeveer said, "and within a few months will be stepped up to 12 times as much." He said almost one-half of the country's gasoline production is being diverted to military purposes, adding that 100-octane gasoline has proved its worth under combat conditions.

"At South Pacific bases," he said, "where air strips have been hacked out of the jungle, it would be necessary to clear 55 yd. more of runway in order to get some of the heavy bombers up off the ground, were it not for the added power which American 100-octane fuel makes possible.

"A whole week's production from the average 100-octane plant is needed to fuel a single 800-airplane raid over Berlin."

Dearborn Links Postwar Jobs to Patent Protection

NEW YORK.—Strong patent protection will be vital to postwar jobs and the creation of new small businesses, R. J. Dearborn, president of the Texaco Development Corp., said last week upon accepting chairmanship of the committee on patents of the National Association of Manufacturers.

"If America is to have enough jobs after the war we must encourage invention in small business," declared Dearborn. "Invention and small business depend on patents.

"Patents protect the little fellow from having his ideas pirated. They give new businesses a chance to get started. This creates jobs and gives us the technical progress that leads to more goods at lower prices for more people."

Dearborn said that the NAM Patents Committee has two major purposes—to develop a better understanding of patents and inventions, and to improve the U.S. patent system.

"Many Americans do not understand that patents stimulate competition," said Dearborn. "Every new idea disclosed in a patent adds to our fund of knowledge. Every invention spurs competitors to find a better one."

National Refining Restricts Operations to Six States

CLEVELAND.—Operations of National Refining Co. are to be restricted to six states, according to plans of Albert A. List, newly elected president. The company, whose activities have covered 25 states, intends to leave the retail marketing field and to sell gasoline and kerosene only to jobbers and lubricating oil to industrial manufacturers. Special attention will be paid to Ohio and Indiana.

"The company will maintain its fleet of trucks and tank cars," List said, "but where we employed 2,000 persons in the past we will have 600."

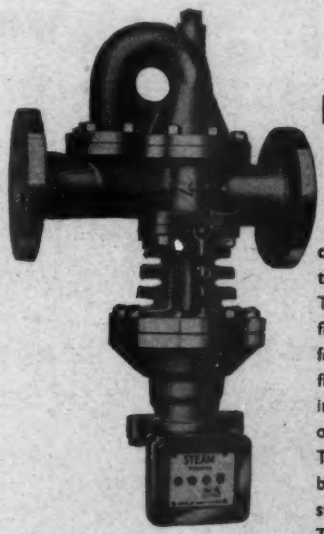
National Refining has a cracking plant at Findlay, Ohio, and the management is said to be investigating the feasibility of increasing the daily capacity of this plant in the postwar period from 9,300 bbl. to 25,000.

List, chosen president at the annual meeting of stockholders, succeeds Kenneth R. Porter, who took office in 1942 after a proxy battle. He is one of a group which acquired control of National Refining last November.

New Order Curbs Use of Naphtha as Motor Fuel

WASHINGTON.—Further steps to curb the use of naphtha as a motor fuel, a practice which has become increasingly prevalent in recent months, were announced last week by the Petroleum Administration for War.

Action was taken by amending a formal order (Petroleum Distribution Order 18), which specifies that consumers and service station dealers cannot include in the base volume of naphtha, upon which their current



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quarterly quotas are computed, any petroleum product sold as a motor fuel during 1942. Quarterly quotas are set at 125 per cent of the volume consumed or sold during the corresponding quarter of 1942.

Under the amended order, these provisions are clearly stated:

1. Naphtha may not be used as a motor fuel.

2. Bulk consumers or dealers who apply for naphtha on a quarterly delivery quota basis cannot include any petroleum product handled as motor-fuel during 1942 in computing current quotas.

3. Whenever a consumer or dealer finds that his naphtha quota—125 per cent of the quantity used in the corresponding quarter of 1942—is insufficient to meet current needs, he may secure an upward adjustment of his quotas by following the procedure set forth in the order.

Aviation-Gasoline Facilities Good Peace Investment

WASHINGTON. — The $760,000,000 expended for 100-octane gasoline facilities should prove a sound investment for the postwar period too, Harold L. Ickes, petroleum administrator, says. Modern refining equipment is of such a flexible character, Ickes pointed out, that the industry will not have to produce aviation gasoline in wartime volume or else abandon its huge investment.

"Expansion in both commercial and private flying is expected to provide a continuing market for aviation fuel," Ickes said. "Many of the new catalytic cracking units can be converted to peacetime use to increase both the quantity and quality of post-war motor gasoline. To a certain extent, the same can be said of facilities for producing various types of blending agents used in 100-octane fuel."

Discussing details of the 100-octane program, Deputy Administrator Ralph K. Davies said:

"Probably no other major war industry has so small a proportion of Government participation. Eighty-two per cent of the ultimate capacity of 100-octane plants in the United States will be privately owned. In terms of investment, private companies will have obligated roughly $550,000,000 of their own money in the expansion of 100-octane facilities between Pearl Harbor and the end of 1944. Government investment in the same period will come to approximately $210,000,000.

"Three-fourths of this government outlay, which came from the Defense Plant Corp., was expended on equipment for small refineries. Petroleum Administration for War has proceeded from the outset on the principle of apportioning responsibility for war production as far as possible among both large and small refiners. In all, 161 different companies are engaged in the 100-octane program."

Alberta Appropriates $250,000 for Tar-Sand Study

OTTAWA. — The Alberta government has voted up to $250,000 for the erection of a pilot plant to assist the Alberta Research Council to determine the practicability of commercial extraction of oil and bitumen products from the Athabaska oil sands. The purpose of the plant is to do experimental work apart from that previously carried on by Abasand Oils of Edmonton, and taken over some time ago by the federal Government.

Hydrogenation in Canada

OTTAWA. — Announcement has been made by Hon. C. D. Howe, federal minister of munitions and supply, that a special laboratory is being built by the mines and resources department to study hydrogenation of coal. In addition to oil production, new processes for the convertion of coal to gas are being studied.

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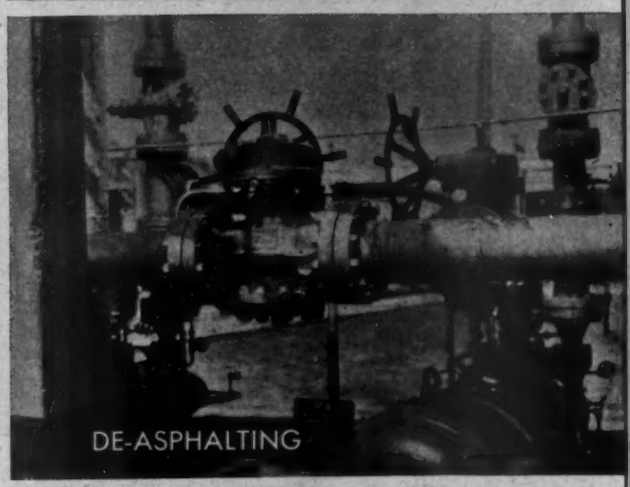
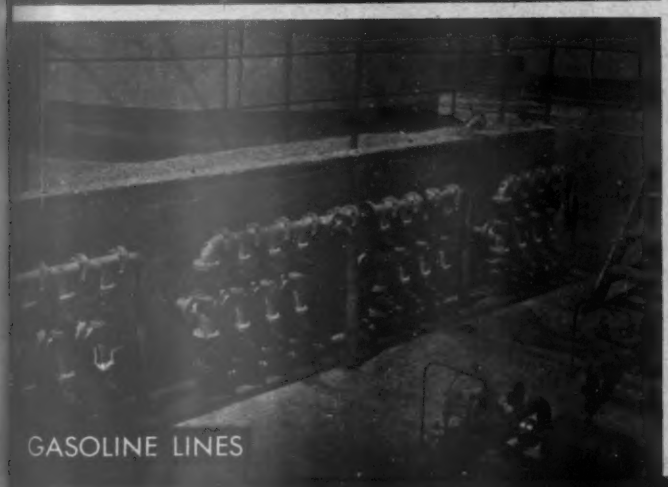


DE-ASPHALTING



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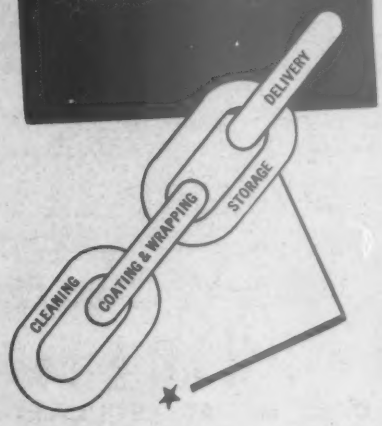

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PIPE LINES

WEP Diverses Shipments Through Products Line

Shipments of 80-octane gasoline, Navy diesel oil and No. 2 heating oil are at present moving through the 20-in. products line of War Emergency Pipelines, Inc. A few weeks ago the system was entirely occupied with handling heating oil for delivery from Beaumont, Tex., to Linden, N. J. The first batch of Navy diesel oil consisting of 250,000 bbl. was started through the line at the end of last week. The status of 80-octane gasoline shipments early this week was as follows: a 340,000-bbl. batch was approaching the East Coast; another large batch was in the line and preparations were being made at Beaumont for starting another batch immediately. Large batches of 340,000 to 450,000 bbl. of 80 octane are being handled. Plans call for an increase in movements of gasoline and a concurrent reduction of heating oil shipments. The 20-in. products line continues to operate at a rate of approximately 180,000 bbl. daily and the 24-in. crude-oil line maintains throughput above the designed capacity of 300,000 bbl. daily.

Some additional facilities are under construction for distribution to points beyond Linden, N. J.; these consist of lines being laid in addition to those provided by the original plans. Bad weather conditions are expected to delay completion of the work for 30 days. Products are being pumped from the Cities Service Oil Co. plant at Lake Charles, La., through the WEP feeder line to the Beaumont terminal. Construction is in progress for laying an extension of the feeder system to Continental Oil Co.'s refinery at Lake Charles.

Tennessee Gas to Borrow $44,000,000 From RFC

Tennessee Gas & Transmission Co., subsidiary of Chicago Corp., is arranging for a Reconstruction Finance Corp. loan of not more than $44,000,000 to finance construction of a 1,263-mile natural-gas pipe line to transport gas from the area around Corpus Christi, Tex., to the Appalachian region. Total cost of constructing the line is estimated at $51,000,000, and at latest report the Tennessee company had entered into numerous contractual arrangements for purchase of a substantial part of the materials and for construction of the pipe line.

Chicago Corp. has guaranteed substantially all the Tennessee company's purchase contracts for materials and a bank credit of $8,000,000, besides agreeing to loan or otherwise furnish all funds in excess of $44,000,000 needed to finish the pipe line and to loan or advance to Tennessee certain amounts over a period of years until these amounts, together with those needed to finish the line, total $12,500,000. This sum would be subordinated to the RFC debt.

Chicago Corp. further agrees, after its obligations with respect to these loans or advances have been discharged, it will purchase on a subordinated basis, amounts of the RFC debt if the Tennessee company's net earnings in any year are less than $3,000,000 and if the latter company is unable to meet the RFC serial maturities.

These purchases would be equal to such deficits of the Tennessee company but only to the extent of (1) proceeds received by Chicago Corp. for gas sold to the Tennessee company or (2) 50 per cent of the cost of gas purchased and sold by the Tennessee company and transmitted through its pipe line—whichever is greater.

Gulf States Oil Co. has assumed 10 per cent of all commitments made by Chicago Corp. in behalf of Tennessee Gas & Transmission Co., including those pertaining to the RFC debt.

Venezuela Petroleum Line Capacity to Be Increased

Capacity of the Venezuelan Petroleum Co.'s 100-mile pipe line from the Santa Barbara field to the Caribbean terminal, Puerto de la Cruz, will be increased from 40,000 to 75,000 bbl. per day. The increase will be effected by adding to the line's pumping equipment. Approval of the necessary federal agencies has been obtained for the shipment of the necessary equipment as well as for the construction of approximately 500,000 bbl. additional storage.

Between the time shipments of crude from the terminal began in August to the end of the year, 3,581,093 bbl. of oil were sent from Puerto de la Cruz. This information is contained in the annual report to stockholders which also states that the

company has completed 70 wells on the Santa Barbara concession and on the neighboring Muri concession.

During the past year the company agreed to amend its concession terms to conform with the new Venezuela petroleum law enacted during the past year.

The company now has about 700 employes and is engaged in providing housing and other facilities for them. The latter include a new school which will accommodate 100 children. Additions to facilities at the terminal include first aid station, baths and an office building..

Stanpac Enlarges Gas System

Standard Pacific Gas Line, Inc., known in the industry as Stanpac, is expanding its system by laying 24,350 ft. of 16-in. pipe, parallel to another stretch of 8-in. line. Stanpac's new project will substantially increase the capacity of the transmission main consisting of 8-in. and 10-in. pipe which extends from the east side of the Rio Vista field to San Pablo. As one part of the job, a 6,580-ft. stretch of 8-in. has been replaced with 16-in. The project will cost $227,000 and will be completed in May, to assure a larger supply of natural gas to a wide variety of industries in Contra Costa County as well as to three large gas and electric generating plants and a number of manufacturing establishments.

A. M. Garber in Charge for Williams Bros. at Houston

A. M. Garber has become general superintendent in charge of construction operations for Williams Brothers Corp. in the area handled by the company's office at Houston, Tex. He succeeds J. R. Horrigan who left to go into the contracting business for himself.

Oil Is Pumped Through Canol Pipe Line

Oil is flowing through the recently completed Canol pipe line from the Norman Wells area in Northwest Territory, Canada, to Whitehorse, Yukon Territory, according to an announcement by Brig. Gen. L. D. Worsham, commanding officer of the U. S. Northwest Service Command. The refinery at Whitehorse is expected to start operations early in May.

Texas Pipe Line Takes Bids for Illinois Job

Bids were being received early this week by Texas Pipe Line Co. for laying 34 miles of 4-in. and 6-in. pipe for a products line from Lockport, Ill., to East Chicago, Ind. Later in the week the contract will be let, according to reports, for this project which is scheduled for completion in May.

Sinclair Pumps Heating Oil Through New Line to Toledo

Sinclair Refining Co. is pumping heating oil through the recently completed 243-mile 8-in. products pipe line from East Chicago, Ind., to Toledo, Ohio, where shipments are loaded in tank cars for delivery to East Coast points.

Kansas-Nebraska Plans 155-Mile Pipe Line

The Kansas-Nebraska Natural Gas Co., Inc., asked the state Corporation Commission for authority to build a 155-mile pipe line across western Kansas and to issue $2,343,000 worth of securities to pay for it.

The proposed expenditure would include a compressor station plus 40 miles of 18-in. pipe line, 100 miles of 12-in. line and 15 miles of 8-in.

The line would tap the Hugoton natural-gas field south of Deerfield and angle north and east, running near Scott City, Wakeeney and Stockton, where it would connect with an existing line. The commission took the application under advisement.

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Exploration and Drilling

Week's Highlights

WITH every bit of tangible news about drilling prospects on the gloomy side, there is an intangible but real feeling of optimism about the future exploration possibilities that gives promise of dominating activities throughout the rest of this year.

The actual news recently has all been bad. The Petroleum Administration for War announced that the proposed 24,000-well program for 1944 might have to be cut down to between 20,000 and 22,000. The position of younger men previously deferred by draft boards is surrounded by a fog of uncertainty, with the probability that very few of those under 26 or 27 will continue to be deferred. Shortages of trucks, drilling equipment, lumber and a host of minor problems all add up to continued difficulties for the exploration and drilling activities of the industry. The Government seemed determined to ram its price subsidy proposal down the throats of the stripper-well operators, and continues to be adamant on the subject of a general price increase.

Despite all these handicaps, in spite of all this discouragement, there is a feeling in the air around the places where oil men congregate. There is a subdued excitement and an air of impending important developments that is like old times. In cold print this does not seem important, but in the petroleum industry and particularly in the exploration branch, how oil men "feel" is a vital factor. Despite all of our science, oil fields are still found by men who drill wells, whether sustained by "hunch," science, hope, or company policies. Price, future market prospects, promising areas, and many other facts always enter in the picture, but in the final analysis, there is something else, and that something else, that "feel" is what makes the oil business different.

It can be sensed in many little ways; the interest in some wildcat that seems like a "long shot"; the way geologists and geophysicists are willing to put up an intriguing but uncertain interpretations on a prospective area to company officials, and the manner in which these officials react to such proposals. There are other signs, but they all add up to straws in the wind, and the trend indicates that the exploration branch of the industry is optimistic.

Solid line charts current weekly completions

COMPLETIONS IN ALL FIELDS . . .

(Week ended April 8, 1944)

	Oil	Gas	Dry	Total	Footage	Total Comp. to date 1944	1943
N. Y., Penna., W. Va.	40	16	3	59	107,197	887	822
Ohio	3	10	7	20	62,719	248	190
Indiana	3	0	2	5	11,153	63	72
Kentucky	1	2	3	6	16,216	144	80
Illinois	18	0	7	25	63,858	428	491
Michigan	3	0	8	11	25,837	140	113
Kansas	12	1	12	25	111,777	463*	363
Nebraska	0	0	0	0	0	8	7
Missouri-Iowa	0	0	0	0	0	4	4
Oklahoma	19	1	8	28	93,175	387	300
Texas:							
North Central Texas	21	0	23	44	140,182	360	318
West Texas	30	0	5	35	164,692	381	226
Texas Panhandle	1	0	0	1	3,250	35	49
Eastern Texas	5	1	2	8	39,017	90	67
Texas Gulf Coast	14	3	9	26	167,935	180	102
Southwest Texas	3	1	1	5	17,968	223	231
Total Texas	74	5	40	119	533,044	1,269	993
Louisiana:							
North Louisiana	3	0	5	8	54,020	85	76
Louisiana Gulf Coast	5	0	3	8	85,360	106	85
Total Louisiana	8	0	8	16	139,380	175	161
Arkansas	5	1	1	7	36,838	60	61
Mississippi and Southeast	1	0	1	2	15,160	39	23
Montana	3	0	0	3	8,738	56	43
Wyoming	2	0	0	2	7,757	37	33
Colorado-Utah-Arizona	0	0	0	0	0	10	5
New Mexico	4	0	2	6	19,450	107	59
California	27	0	7	34	140,275	484	288
Total United States	223	36	109	368	1,392,574	5,009	4,108
*Total previous week	223	33	95	351			
Week ended April 10, 1943	190	31	137	358			

*Revised.

KANSAS

Simpson Discovery In Pratt County

LION OIL 1 Andrews, SE SE SE 24-29-14w, in southwestern Pratt County, was reported to have encountered a good thickness of Simpson sand, which on drill-stem test, filled up with 1,600 ft. of clean oil. Unofficial reports placed top of Simpson at 4,405 ft., with drill-stem test made at 4,440 ft. Latest reports indicated that the well would be carried on down to test the Arbuckle lime before final decision on completion would be made.

The results of the Lion test will probably stimulate further tests in this area of Kansas for Simpson production. Several other areas in Pratt County are reported due for testing soon, particularly along the trends between northwest Barber County production and northeast Pratt County pools.

KANSAS WILDCAT COMPLETIONS

Barber County: Champlin 1 Gentry, NE SW 13-33-15w, dry, TD 5,370 ft., Arbuckle 5,327 ft.

Barton County: Shell 1 Stueder, NW SE 36-17-12w, dry, TD 3,382 ft., Topeka 2,698 ft.

Brown County: Ohio Oil 1 Peck, 15-1-16e, dry, TD 2,880 ft., Hunton 2,780 ft.

Ellsworth County: Benson Drilling Co. 1 Morevak, SW SW NW 22-15-10w, dry, TD 3,291 ft., Arbuckle 3,280 ft.

Harvey County: Carlock et al 1 Schragg, NW NE 25-22-3w, dry, TD 3,084 ft., Arbuckle 3,792 ft.

Nemaha County: Ohio Oil 1 Lamparter, NE SW 3-2-14e, dry, TD 3,947 ft., St. Peter 3,858 ft., pre-Cambrian 3,938 ft.

Reno County: Phillips Petroleum 1 Wenzel, NE SE SW 15-26-5w, dry, TD 4,138 ft., Arbuckle 4,124 ft.

Stafford County: Bridgeport 1 Cooper "A," SW cor. 29-24-11w, dry, TD 4,102 ft., Arbuckle 4,078 ft.

APPALACHIAN FIELDS

Activity Increasing But Few Wildcats Under Way

PITTSBURGH. — Activity in the lower eastern fields at the beginning of the month is increasing with over 200 wells in West Virginia drilling, deepening or about to start and 65 in southwest Pennsylvania. Few deep wildcats are under way at present but there are tentative locations in sight. In Union and Williams district, Wood County, West Virginia, the most recent activity has developed.

With the Oriskany horizon only 10 ft. away, the elevators broke in the rotary test of Ohio Oil Co. on the Kaemmerling tract in Dry Fork district, Tucker County, West Virginia, when only two stands of pipe and part of a third were out of the hole and the slips failed. It is now shut down at 7,966½ ft. waiting on tools with the possible damage to the drill pipe not determined.

Neither South Penn Oil Co.'s test on the Louise Kerr farm in Center Township, Monroe County, West Virginia, nor National Supply Co.'s test on their fee at Ambridge in Beaver County, Pennsylvania, reached the Oriskany sand during the week. Both are drilling through the Onondaga lime or caprock of the Oriskany. Both will be important if producers.

In southwest Pennsylvania, the wildcat of the Manufacturers Light & Heat Co. on the J. G. Hockenberry farm in Mercer Township, Butler County, was cased below the Medina to 6,691 ft. with 7-in. casing and drilling has been resumed scheduled for the Trenton. This will be the first test to that horizon in southwest Pennsylvania.

In North Strabane Township, Washington County, Pennsylvania, Carnegie Natural Gas Co. completed a fair gas well, 961 William A. Donaldson, gaging 709,000 cu. ft. from the Second Salt sand topped 1,174 ft.; gas 1,226-30 and 1,232 ft., total depth 1,232 ft.

OKLAHOMA

New Wilcox Prospects Looking Good

OKLAHOMA prospects were looking good as the result of the news this past week. Carter Oil's Cottingham well in McClain County, the Wilcox producer that opens up a large play in the Anadarko basin, continued to flow both oil and water in varying quantities as various sized chokes were used in experimental tests.

Gulf Oil 1 Hare, NE SW 8-8-20w, Washita County, offset to the granite wash discovery well in the West Sentinel field, on drill-stem test, was estimated to be good for 50 to 60 bbl. of oil per hour from 5,563-74 ft., with drilling continuing to the granite wash pay of the discovery well, estimated about 1,000 ft. lower.

The West Edmond field celebrated its first birthday with a number of wells nearing critical depths in the north end where many geologists expect the Hunton to pinch out and a Wilcox bump to be found. Mid-Continent Petroleum continued to refuse to put out information on its 1 Tubbs, offset to the Wilcox discovery well in the West Moore field but reports persist that a good thickness of Wilcox has been found with substantial saturation.

OKLAHOMA WILDCAT COMPLETIONS

Creek County: Dale Sneed 1 Easton, SW SW SE 12-14n-10e, 90 bbl. oil per day, TD 2,565 ft., Dutcher 2,500 ft.

Garvin County: Ohio Oil 1 Dorchester, NW NW SW 2-3n-1w, dry (junked), TD 4,750 ft.

Lincoln County: Creekmore-Rooney 1 Sturdevant, SE NW NW 33-12n-5e, dry, TD 5,017 ft., second Wilcox 5,000 ft.

Logan County: Atlantic 1 Kerfoot, SE SE NE 31-18n-3w, 100 bbl. oil per day, TD 6,323 ft., second Wilcox 6,268-76 ft.

Pawnee County: Curtis Oil 1 Rice, NW NW SW 13-23n-5e, dry, TD 3,139 ft., Mays 3,074 ft.

Seminole County: R. B. Patterson et al 1 Butner, NW NW SE 3-9n-8e, dry, TD 3,546 ft., Cromwell 3,520 ft.

DAILY AVERAGE PRODUCTION FOR WEEK

	Apr. 8 crude oil	Distillate, allied products	April PAW quota all oils	Apr. 1 crude oil
Arkansas	79,200	5,000	81,700	79,100
California	825,250	47,000	876,400	827,500
Colorado	8,060	.....	7,000	8,250
Eastern	76,600	3,600	81,000	70,150
Illinois	224,100	13,000	228,000	215,500
Indiana	13,900	.....	13,600	13,800
Kansas	257,300	5,800	290,800	270,100
Kentucky	21,700	2,700	25,700	22,300
Louisiana	358,500	34,000	381,700	360,950
North Louisiana	76,000	.....	.....	76,900
Louisiana Gulf	282,500	.....	.....	284,050
Michigan	48,850	300	53,300	50,850
Mississippi	41,400	.....	45,000	41,300
Montana	21,690	300	24,300	21,900
Nebraska	930	.....	1,000	1,250
New Mexico	112,550	4,900	116,600	113,000
Oklahoma	330,800	28,000	356,000	330,100
Texas	1,910,350	127,000	2,043,000	1,863,500
East Texas	362,300	.....	.....	365,450
West Texas	374,000	.....	.....	340,750
North Central Texas	143,850	.....	.....	142,600
East Central Texas	127,250	.....	.....	116,600
Texas Panhandle	91,100	.....	.....	92,850
Texas Gulf	716,800	.....	.....	710,700
Southwest Texas	95,050	.....	.....	94,550
Wyoming	87,330	6,900	99,900	87,900
Total United States	4,418,510	283,500	4,725,000	4,377,450

Total production January 1-April 8, 1944 ..... 466,035,391 bbl.
Same period last year ..... 380,493,660 bbl.

CALIFORNIA

Several Deep Tests Under Way in Existing Fields

LOS ANGELES.—The wildcat recently completed in the El Segundo district of Los Angeles Basin by Edwin and Harold Pauley, which was drilled from a surface location several hundred feet from the outer boundary of the Hyperion sewer farm, is undoubtedly an edge well and in addition is producing with a fish in the bottom of the hole. This wildcat was finished pumping 150 bbl. daily from 7,290 ft. but has not maintained this daily rate since completion.

Standard Oil Co. of California proved conclusively several days ago that no deeper commercial production could be expected in the eastern segment of the Inglewood field as its 105 Baldwin Cienega encountered basement material at 12,276 ft. Some slight showings were logged higher up in the hole and below the Rindge zone and they will be tested on the way out. The Miocene has proved distinctly disappointing at Inglewood as the only large production developed to date has been in the northwestern end of the structure where a complicated fault system exists and apparently governs production. The Sentous zone in other parts of the field lacks permeability and porosity sufficient to permit the completion of good flowing wells.

On Simmons Island in the extreme eastern end of Suisun Bay, Standard got a gas blow at a daily rate of 5,000,000 cu. ft in 1-A Honker from a gas sand at 7,200 ft. This wildcat, one of several drilled by Standard in the general area, was carried down to 8,304 ft., and then redrilled to 7,492 ft. A 5,000,000-ft. gas well at this depth could hardly be called a commercial producer and for this reason further tests may be expected to be carried on before the status of the wildcat is determined. Several deep tests in existing fields are under way and in some of these districts the outcome of drilling may prove very important.

R. S. Lytle is working on a deep test in the Pleasant Valley field in Fresno County and in this hole the objective is the Cretaceous as production is at present coming from the Eocene. In the Wilmington field, Union Pacific Railroad Co. is conducting a deep test survey but in this case the operator is almost sure of what will be found. This deep test is Union Pacific's 237 located on fee owned acreage. The search for deeper production at Inglewood as noted above has proved a failure but deeper drilling in the Buena Vista Hills section of the Midway-Sunset field

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was successful in proving up a new lower zone of probable Pliocene age. At least five new wells will be started at Buena Vista Hills at once.

CALIFORNIA WILDCAT COMPLETIONS

Downey wildcat district, Los Angeles County: Tide Water Associated Oil Co. 10-1 Downey, 4-3s-12w, dry in gray sand, TD 7,945 ft., no showings of oil or gas, did not get out of Pico formation of upper Pliocene age.

Kerman wildcat district, Fresno County: Seaboard 1-28 T.W.A., 28-14s-17e, dry in Cretaceous shale, TD 6,475 ft., no showings of oil or gas, top Cretaceous 6,332 ft.

La Habra wildcat district, Los Angeles County: Union 14 Sansinena, 32-2s-10w dry in gray sand, TD 4,700 ft., no showings of oil or gas recorded.

Magunden wildcat district, Kern County: Seaboard 2 Garrison-Davis, 30-29s-29e, dry as unproductive, TD 2,361 ft., bailed dry, no fluid, bottomed in basement.

Suisun wildcat district, Solano County: Standard 1 Stewart, 25-3n-1w, dry, TD 8,728 ft., minor gas showings logged.

EASTERN TEXAS

Four New Wildcat Tests Staked

DALLAS.—Although wildcatting in East Texas has slowed down considerably due to disappointments in several deep tests drilled throughout the area in the past few months, four important new tests were announced during the week. In Wood County 6 miles east by north of Quitman, Oak Grove area, Fisher Drilling Co. will make another attempt to develop production from the Woodbine sand which showed encouragement in two previous wells. The company has staked location for 1-B McCorley, about ¼ mile southeast of Fisher and Jackson 1-A McCorley, which showed very heavy black oil from 5,416-56 ft., the oil rising 5,200 ft. in the hole, but no method of producing could be devised due to the oil being of about 8° gravity, and would congeal in the hole before reaching the top. This well was drilled as a twin to the first well drilled in the area which was junked at 6,722 ft., when drill pipe was stuck. A saturated section was logged in the Woodbine horizon but the well was carried below this to test the Paluxy sand. Two miles east of these wells a third well was drilled by the same operators to 6,016 ft., and was abandoned as dry without showing anything encouraging.

Van Zandt County.—Humble Oil & Refining 1 Joe Surratt, W. Wade Survey, 1 mile southeast of Edgewood, is to be a Travis Peak test, projected to 8,400 ft.

Titus County.—Four miles southeast of Mount Pleasant, Humble Oil & Refining 1 Annie B. Stevens, George Clapham Survey, will be a new 8,000-ft. test.

Henderson County.—The Paluxy sand will be the objective of E. B. Germany & Sons 1 H. W. Bonsell, located on 100-acre tract of Vicente Michelli Survey, 2 miles southwest of Eustace in northwest Henderson County. This locations falls 9 miles due east of the Flag Lake Woodbine sand pool, which is on the main Balcones fault system.

Anderson County.—First completion in some time for the Long Lake pool in Tide Water and Seaboard 15 J. O. Monnig, which made 175 oil per day through perforations, total depth 5,260 ft.

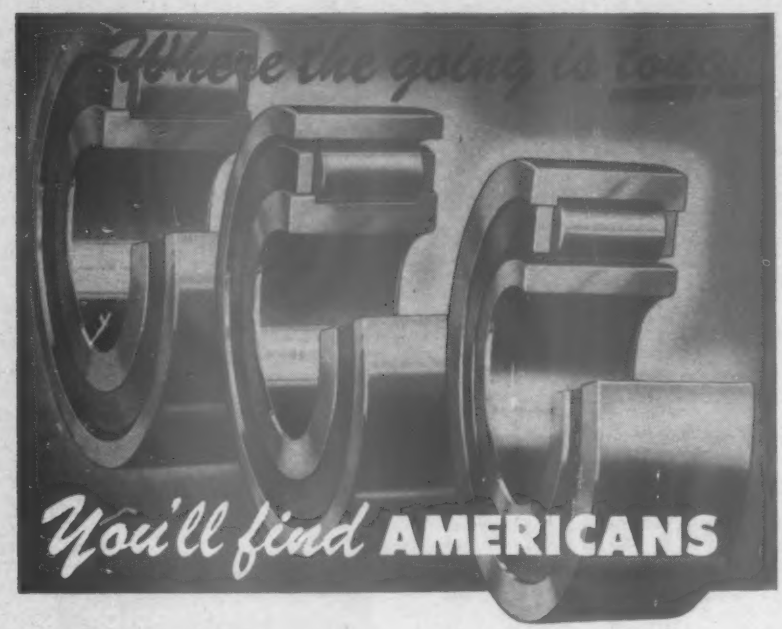
Henderson County.—Stanolind Oil & Gas 2-D Tri-Cities Unit, in the Tri-Cities gas-distillate pool, made 43.79 bbl. 67.6° gravity distillate from total depth 6,743 ft.

Wood County.—Amerada, Gulf & Manziel 1 M. A. Hudson Unit, northwest edge of the Manziel pool, was completed for 223 bbl. per day through perforations opposite the Paluxy at 6,328-50 ft., total depth 6,385 ft.

EAST TEXAS WILDCAT COMPLETIONS

Smith County: The Texas Co. 1 Leila Nix, 380 ft. from S and W, 8-ac. tract, Nimrod Doyle Sur., 2 mi. S-SE Starville, elev. 451 ft., Woodbine 3,990 ft., Georgetown 4,412 ft., Goodland 5,548 ft., Paluxy 5,654 ft., Glen Rose 6,000 ft., dry at TD 6,030 ft.

Hunt County: Humble Oil & Ref. 1 E. M. Anderson, 720 ft. from N, 750 ft. from W, 101-ac. tract, Juliet Anderson Sur., elev. 599 ft., dry at TD 2,617 ft.



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from N & W, R. K. Mayes Sur., dry at TD 2,794 ft.

Bruce Sullivan 1 R. S. Perry, 923 ft. from E, 467 ft. from S, Sec. 706, TE&L Sur., 2½ mi. NW Proffitt, dry at TD 1,900 ft.

WEST CENTRAL TEXAS WILDCAT COMPLETIONS

Coleman County: Chas. P. Franchot & W. E. Ball 1 H. C. Michie, 1,938 ft. from N, 660 ft. from E, J. Luckenbach Sur., 4 mi. west of Burkett, elev., 1,658 ft., pumped 14.17 bbl., lime pay 3,311 ft., Caddo 2,754 ft., TD 3,325 ft. Discovery.

Callahan County: H. G. Daniels 2 Sarah C. Hennessy, 440 ft. from N, 830 ft. from E, Sec. 1, Blk. D, SP Ry. Survey, elev. 2,009 ft., dry at TD 1,657 ft.

Stephens County: Beacon O. & R. 1 Q. Corbett, Sec. 1,070, Blk. 3, SP Ry. Sur., elev. 1,142 ft., pumped 15 bbl., pay 3,851 ft., plugged back to 3,861 ft. Discovery.

Northern Ordnance, Inc. 1 Norton Properties, 330 ft. from N & E S½ Sec. 1,218, TE&L Sur., dry at TD 4,553 ft.

Taylor County: West Central Drilling Co. 1 Jessie Brown, 330 ft. from N & W 217.55-ac. tract, David Bruce Sur., dry at TD 2,370 ft.

Throckmorton County: Grisham - Hunter Corp. 2-D R. W. Kelly est., 678 ft. from N, 190 ft. from E, 356.7-acr. tract, Brooks & Burleson and Joe LaBlue Sur., elev. 1,311 ft., IP 128 bbl., pay 812 ft., TD 817 ft. Discovery.

ILLINOIS

Edwards and White County Wildcats Showing Oil

CENTRALIA, Ill.—Prospective new pools in Edwards and White counties, a good Devonian lime well in the Marine pool in Madison County, and several good completions in the Clay City area in Wayne County, featured the news in the Illinois fields in the past week.

Superior Oil Co. 1 J. Lambert, C S½ NE SW 31-1s-11e, Edwards County, 1 mile northeast of Albion, in a 30-minute drill-stem test in McClosky lime at 3,138-49 ft. developed 2,400 ft. of clean oil, promising a new pool. In White County, just north of the town of Herald, Cascade Refining Co. and C. Angle 1 D. M. Marlin, trustee, SW NW SW 26-6s-10e, were preparing to test saturated Aux Vases sand at 2,896-2,904 ft.

The best of several new Clay City completions owned by Pure Oil Co. was 1 McDowell Consolidated, C SE NW 23-1n-8e, which pumped 693 bbl. initially, after an acid treatment in McClosky lime at 3,067-80 ft. Pure 1 Mayes Consolidated, C SE NW 15-1n-8e, pumped 546 bbl. from acidized McClosky lime at 3,061-79 ft. Two other 250-bbl. wells rewarded the Pure for its drilling activities in the same pool.

Texas Co. deepened an old Devonian lime well in the Salem field to Trenton lime at 4,515 ft., total depth 4,625 ft. and it flowed 76 bbl. a day. It was 21 Young, NW SE NE 20-2n-2e.

In the Marine pool, Madison County, Rockhill Oil Co. 1 W. H. Pence, SE SW SW 10-4n-6w, pumped and flowed 242 bbl. a day from Devonian lime at 1,742-45½ ft.

ILLINOIS WILDCAT COMPLETIONS

Effington County: Kingwood 1 J. S. Danks, SE SE SE 25-6n-4e, dry at 2,591 ft. Lower Kinkaid 1,611 ft., Barlow 2,145 ft., Benoist 2,300 ft., Aux Vases 2,366 ft., Ste. Genevieve 2,420 ft., McClosky, 2,460-66 and 2,490-98 ft.

Montgomery County: Alonzo D. Malone 1 L. J. Todt, NE NW NE 21-11n-4w, dry at 632 ft.

ROCKY MOUNTAIN

Garland Dome Well Responds to Shooting

DENVER, Colo.—The second of two wells drilled on the Garland dome, Big Horn County, Wyoming, to test oil possibilities in the Tensleep horizon on the flanks of the structure below the gas cap proved a favorable surprise last week. This was Ohio Oil Co. 5 Ohio-Kinney-Coastal unit, NW SW SW 13-56n-98w, on the northwest flank. It was completed last month in the Tensleep at 4,350 to 4,485 ft. and pumped at the rate of 135 bbl. per day. The Ohio-Kinney-Coastal well was shot with 180 qt. in three stages at 4,380 to 4,470 ft., and in 24 hours ending at 7 a.m. April 3 it put 352 bbl. of pipe-line oil into the tanks. Testing at the full capacity of the pump continued for 45 hours when available tankage was full. During that period it made 666 bbl., or an average of 14.8 bbl. per hour.

In reporting recently two important tests to be drilled in the Rangely field, western Colorado, both gave Wasatch Oil Refining Co. as the operator. One of these wells, 1-D Gentry, 3-1n-102w, will be drilled by Newton Oil Co. of Denver, on its own land. The Wasatch test is 1 McLaughlin, 32-2n-102w.

High bonus requirement.—The Interior Department has set the minimum acceptable bonus bid on an 80-acre tract in the Lost Soldier field to be received in Washington by noon May 1 at $2,000 per acre. The tract consists of N½ NW 14-26n-90w, at the south end of the field. It has never been tested to the Tensleep, but extensions of the pool in that horizon on the north and east sides last year indicate it is within the productive area.

East Lance Creek.—Continental Oil Co., operator for the unit, has spudded 1 Wright, NW SW NW 25-36n-64w, a wildcat on the Lance Creek anticline, the local dome being known as East Lance Creek. It is 3½ miles east of 1 Leach in 29-36-64, which was completed in the Dakota at 3,808-95 ft. in 1937 for 8,808,000 cu. ft. of gas after plugging back from the Minnelusa, which was dry at 6,403 ft., total depth.

Little Buffalo Basin.—Stanolind Oil & Gas Co. 2 Unit, NE NE NW 12-47n-100w, Little Buffalo Basin field, had 20,000,000 cu. ft. of gas per day in the Lakota sand at around 2,500 ft. It is a mile north of Fred Goodstein 1 Pedley, the discovery well in the Tensleep. Stanolind test is drilling to the deeper horizon. The Pedley well, which made a maximum of 136 bbl. per day in a swabbing test, is now on the pump and making 180 bbl. per day and showing an increase in pressure and improvement in gravity. Tanks are being erected for a sustained production test. This well had 5,000,000 cu. ft. of gas in the Lakota which was passed up on the way down to the Tensleep.

MICHIGAN

Arenac County Well Flows 2,300 Bbl. Natural

SAGINAW, Mich.—Completion of Charles W. Teater 1 Haslett in Section 14 of Adams Township, Arenac County, for natural initial of 2,300 bbl. a day featured the week in Michigan oil fields as two other above-average producers were developed and eight other tests were completed as dry holes, seven of them wildcat explorations in as many counties. Other production included a 720-bbl. test in Newaygo's Goodwell field and a 430-bbl. well in Fork-Mecosta.

Drilling permits for the year increased to 130, nine being granted last week by the state Conservation Department, two for locations in Clare County, two in Arenac, one each in Bay, Huron, Ottawa, Mecosta and St. Clair.

MICHIGAN WILDCAT COMPLETIONS

Allegan County, Monterey Township: Wil-

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, General Land Office, Washington, D. C. Notice is hereby given that the N½ NW¼ Sec. 14, T. 26 N., R. 90 W., 6th P.M., 80 acres, Lost Soldier oil and gas field, Wyoming, is offered to the responsible qualified bidder of the highest cash bonus per acre for lease under section 17 of the mineral leasing act, as amended by the act of August 21, 1935 (49 Stat. 674, 30 U. S. C. 226). The minimum acceptable bonus is $2,000 per acre. Sealed bids will be received in the office of the Secretary of the Interior, Interior Building, Washington 25, D. C., up to 12 noon May 1, 1944. Each bidder must submit a certified check or cash for one-fifth of the amount bid, payable to the order of the Treasurer of the United States, and file the showing of qualifications to receive a lease required by section 7 of Circular 1386. The remainder of the bonus and the annual rental at the rate of $1 per acre must be paid and a $5,000 corporate surety bond must be furnished by the successful bidder prior to the issuance of the lease. The deposits of the other bidders will be returned. The envelopes should be plainly marked "Bid for lease in Lost Soldier field. Not to be opened before noon May 1, 1944." No bid received after the time fixed herein for submitting bids will be considered. Bidders are warned against violation of section 59, U. S. Criminal Code, approved March 4, 1909, prohibiting unlawful combination or intimidation of bidders. The right is reserved to reject any and all bids in the discretion of the Secretary of the Interior. Fred W. Johnson, Commissioner.

liam Moser 1 Brenner, SE NE NW 22-3n-13w, dry in Traverse limestone, TD 1,787 ft.

Antrim County, Echo Township: Sohio Petroleum Co. 1 East Jordan Lumber Co., S½ NE NW 9-31n-7w, dry hole, TD 2,113 ft.

Genesee County, Forest Township: Hugh H. Heinig 1 Barden, NE SE NE 9-9n-8e, dry in Traverse, TD 2,008 ft.

Kalamazoo County, Alamo Township: Harris Oil Co. 1 Adem Drobny, SW SW SW 31-1s-12w, dry in Traverse limestone, TD 1,275 ft.

Mecosta County, Grant Township: Eugene Hilliard 1 Consumers Power Co., C S½ SW NW 8-16n-9w, dry in Dundee, TD 3,600 ft.

Missaukee County, Clam Union Township: Gordon & Rowmor Corp. 1 William and Anna Kraker, C W½ SW SW 34-21n-6w, dry in Dunee, TD 3,863 ft.

Ottawa County, Olive Township: Clifford A. Perry 1 John D. Bloemers, NW NW NE 11-6n-15w, dry in Traverse limestone, TD 1,796 ft.

TEXAS GULF COAST

New Frio Sand Discovery Believed Opened

HOUSTON.—A new Frio sand discovery is believed to have been opened in Matagorda County with the showing of Ohio Oil Co. and Continental Oil Co. 1 Heffelfinger in the P. Burnett Survey. Three feet of sand showing oil was recovered in a core from 8,835-40 ft., where a drill-stem test recovered 300 ft. of 46-gravity oil. Other sands which have promise of production were logged at intervals from 8,315-71 ft., 8,540-45 ft., and 8,651-74 ft., and the well is coring ahead below 8,910 ft. The well is about 1½ miles south of El Maton, a few miles southwest of the old Markham field.

Wilcox sand production was established in the Livingston field, Polk County, with the completion of Humble Oil & Refining Co. 7 Granbury & Smith, completed for an initial production of 668 bbl. per day through a ¼-in. choke. Gravity tested 36.3° with tubing pressure 1,500 lb. Total depth is 7,886 ft., with production from sand at 7,005-20 ft.

TEXAS GULF COAST WILDCAT COMPLETIONS

Brazoria County: Kirby-Continental 1 Ramsey State Prison Farm, dry at 8,516 ft.

Jefferson County: Glenn H. McCarthy 1 Lohmann, T&NORR Sur. 71, dry at 9,696 ft.

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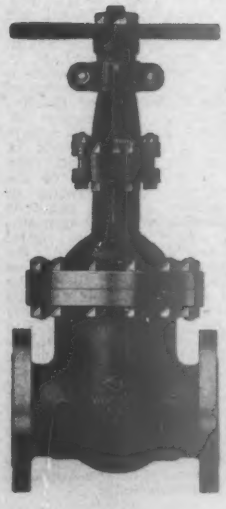
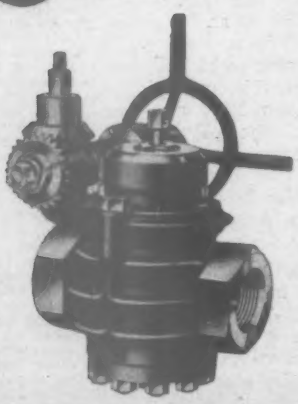




The Newman-Milliken Glandless Lubricated Plug Valve has many unique features . . . a parallel plug always in close working contact with its body seating—no grit can therefore get between these two surfaces. No gland, no packing, no gaskets. Self sealing and a visual check on full lubrication. Port openings equal to full size area. Opened and closed by a quarter turn of the plug.

Newman, Hender & Co. Ltd
WOODCHESTER NH GLOS. ENGLAND

SOUTHWEST TEXAS

Two Gas-Distillate Pools Showing in Goliad

CORPUS CHRISTI.—Search for Wilcox production in Southwest Texas was accelerated with the discovery of two new pools, both of which are gas-distillate fields, in Goliad County.

Although no official gage has been made, H. H. Coffield 1 Chilton, 2½ miles south of Weesatche, Goliad County, was flowing gas and distillate while testing through perforations at approximately 7,986 ft. Total depth is 9,002 ft., with 5½-in. casing cemented at 8,150 ft.

On strike with the above well and in the R. Walker Survey, 10 miles northwest of Goliad, Continental Oil Co. 1 Heard, perforated casing at 8,490-95 ft., and is flowing an unestimated amount of gas and distillate through a 7/64-in. choke.

Gas-distillate production was opened in Hidalgo County, 3 miles south of Aurora, with the showing of Baldridge & King 1 Richard King which is shut in awaiting orders after the well flowed gas and distillate when tested through perforated casing at 6,922-27 ft. The structure is situated in the San Salvador Del Tule grant.

SOUTHWEST TEXAS WILDCAT COMPLETIONS

Bee County: Bridwell 3 Ray, A. Burke Sur., dry at 3,762 ft.

Rowe & Lange 1 Jancha, Bee Co. School Land Sur., dry at 4,525 ft.

Jim Hogg County: Texas 2 Yaeger, dry at 3,375 ft.

Jim Wells County: H. F. Wilcox 1 Almond, Sur. 13, TD 5,400 ft., perf. csg. 3,227 ft., IP 1,500,000 cu. ft. gas, 2 bbl. dist.

Karnes County: Ce-Beth Oil Co. 1 Mischner, J. F. Miller Sur., dry at 6,606 ft.
San Patricio County: Southern Minerals Corp. 1 Miller, G. Morris Sur., dry at 6,850 ft.

PERMIAN BASIN

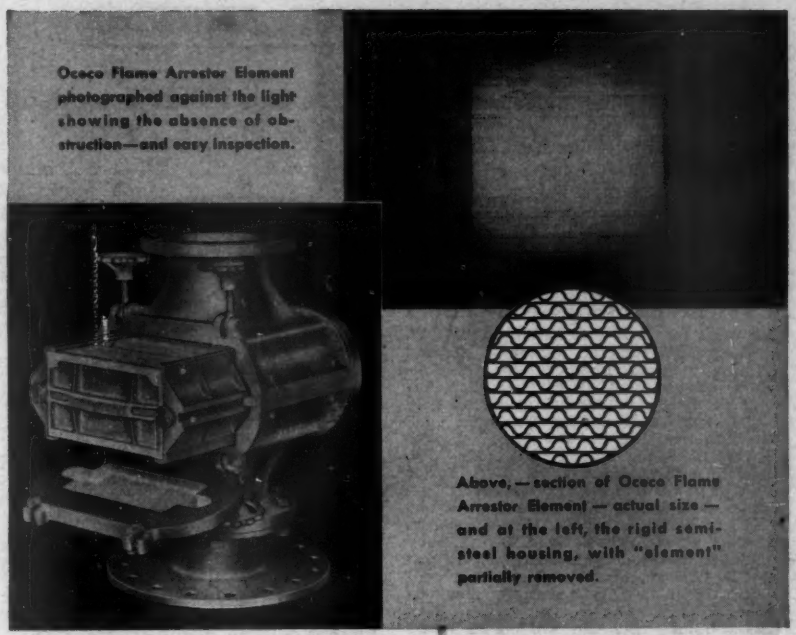
Gages Reported on Three New Discoveries

MIDLAND, Tex.—Final gages were reported on two new discoveries, both in the north Basin country, in adjoining counties. In Hockley County, swabbing gage of 58 bbl. 37° gravity oil plus 79 bbl. of water was announced for Stanolind Oil & Gas Co. 1 Tom Cobb, new San Andres lime discovery in League 75, Haskell County School Land Survey. This well topped its pay at 4,593 ft., drilled to total depth 4,685 ft., and plugged back to 4,663 ft. for completion. It is waiting on pumping unit for final completion. Fourteen miles southwest of this well, in Cochran County 2½ miles northeast of the Sunray-Wright area, E. Constantin and Associates 1 G. W. Moore, Labor 9, League 64, Midland County School Land, was completed for a pumping potential of 253 bbl. per day. This well topped San Andres lime pay at 4,862 ft., treated with 3,500 gal. acid, and is bottomed at total depth 4,928 ft. Both of the above wells have been under process of completion for several weeks, and have been delayed waiting for pumping equipment. Two and one-half miles northwest of this last-mentioned discovery, San Andres Production Co. has staked 1 M. B. Clouser in Labor 18, League 62, Midland County School Land, to go 6,000 ft. in search of production. In far western Cochran County, L. A. Douglas 1 Foster Petroleum-R. E. Sherrill, NW SE Section 10, Block W, Public School Land, is new location for 5,500-ft. test.

Winkler County.—Stanolind Oil & Gas 1 Sealy-Smith Foundation, SW SW Section 50, Block A, G&MMB&A Survey, 6 miles northwest of Monahans pool, was finally gaged at 298 bbl. per day from Clear Fork pay at 6,005-6,248 ft., plugged back depth.

Ward County.—Stanolind Oil & Gas Sealy-Smith Foundation, Section 38, Block A, G&MMB&A Survey, Monahans pool, has finally been completed flowing potential of 301.42 bbl. per day with 97.3 bbl. of water, from Ellenburger pay 10,350-423 ft., total depth 10,496 ft.

Pecos County.—A new shallow lime producing area has been opened 2 miles south of the Lehn pool. Debs Patillo 1 Iowa Realty Trust, Section 61, Block 10, H&GN Ry. Survey, has been making about 20 bbl. per day, after treating formation with 1,000 gal. acid at plugged-back depth 1,325 ft., total depth 1,400 ft. Pumping


Oceco Flame Arrestor Element photographed against the light showing the absence of obstruction—and easy inspection.
Above,—section of Oceco Flame Arrestor Element — actual size — and at the left, the rigid semi-steel housing, with "element" partially removed.

OCECO STRAIGHT THROUGH FLAME ARRESTOR PASSAGES

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2. **Permit free tank venting**
3. **Minimize entrainment of condensates**
4. **Assure easy quick inspection**

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equipment is being installed. One-half mile south of this well, J. L. Cooper et al 1 Iowa Trust topped the pay at 1,250 ft., and was drilling ahead to determine the extent of the pay.

Crane County.—The new Devonian discovery of The Texas Co. 1 Hobbs, near Upton County line, was coring and drilling ahead after assuring production. No further shows were reported in drilling to total depth of 5,622 ft.

WEST TEXAS WILDCAT COMPLETIONS

Cochran County: E. Constantin, Jr., 1 G. W. Moore, SW cor. Lab. 9, Lge. 64, Midland County School Land, 2½ mi. NE Sunray-Wright pool, IP 253 bbl., San Andres lime pay 4,862 ft., acid 3,500 gal., TD 4,928 ft. Discovery, Whiteface pool.

Ector County: Humble Oil & Ref. 1 Gist, NW SW Sec. 46, Blk. 42-1s, T&P Ry. Sur., semiwildcat, ½ mi. East Foster pool production, dry at TD 4,814 ft.

Gaines County: Northern Ordnance Inc. 1 Birge, 660 ft. from S & E, Sec. 1, Blk. C-43, Public School Land, 14 mi. E by S Seminole pool, elev. 3,146 ft., dry at TD 3,830 ft., abandoned short of contract on account running low on markers.

Reeves County: Standard Oil Co. of Tex. 1 Randolph, 1,980 ft. from N and E, Sec. 46, Blk. 57, Twp. 2, T&P Ry. Sur., dry at TD 3,150 ft.

Winkler County: Stanolind Oil & Gas 1 Sealy-Smith Foundation, 660 ft. from S and W, Sec. 50, Blk. A, G&MMB&A Sur., 6 mi. NW Monahans pool, elev. 2,778 ft., flowed 298 bbl. 8/64-in. choke, 37 gravity, Clear Fork pay 6,005 ft., PB to 6,248 ft. from TD 6,305 ft.

SOUTHEAST NEW MEXICO

HOBBS, N. M. — DeKalb Agricultural Association 1 Magnolia-Stovall, 8-20s-38e, wildcat northeast of the Skaggs area, had a blowout from the Yates zone topped at 3,040 ft., and an increase of gas was found at 3,164 ft. The hole is bottomed at 3,175 ft., and operators are trying to kill the gas. Heavy gas flow from the Yates is usually indicative of favorable structural position in wells in this part of the Permian Basin. Only a slight show of oil was found in Magnolia Petroleum 1-U State, wildcat northwest of Tatum, which topped porous zone at 4,980 ft., and it is drilling ahead after drill-stem test from 5,042-5,114 ft., showed salty drilling mud.

PANHANDLE

AMARILLO, Tex.—New wildcat location for Donley County is Magnolia Petroleum Co. 1 C. T. Murtrey, in Section 7, Block E, D&P Ry. Survey, 1½ miles southwest of Evans, near the north line of the county.

LEGAL

Notice of Oil and Gas Lease sale: The U.S. Department of Agriculture will award leases on 18 tracts of approximately 2,480 acres each in Cochran County, Texas, on former Slaughter Ranch. Rent $1.00 per acre. Awards limited to 1 tract per lessee. Sealed bids to be publicly opened May 1. Bid forms and additional information can be secured from Ray E. Davis, Acting Regional Director, Farm Security Administration, Old Post Office Building, Amarillo, Texas.

OHIO, KENTUCKY

Three Gas Fields Extended

ZANESVILLE, Ohio. — The Lake Township gas pool in the Ashland field was extended ¾ mile southwest by Sheridan and Hogue's Josephine Ecki completion in Section 21. The well had a shut-in volume of 1,600,000 cu. ft. and a rock pressure of 1,075 lb. in the first Clinton at 2,840-50 ft.

The East Killbuck pool was extended a location to the northwest by Ohio Fuel 1 William Schuler in Section 14. The gage was 1,600,000 cu. ft. natural from sand at 3,486-3,509 ft.

Glenn Harmon et al have found an indication of a new gas pool ⅝ mile west of a partially depleted pool in the north end of Sullivan Township, Ashland County. The completion, Charles Beard 1, Lot 69, was shut in after shot at 245,000 cu. ft. with 1,200 lb. pressure from sand at 2,586-93 ft. A test in the line will be made before further drilling in the area.

OHIO WILDCAT COMPLETIONS

Coshocton County, Mill Creek Township: S. E. Large et al 1 C. A. Karr, Lot 14, Clinton 3,640-80 ft., dry, TD 3,780 ft.

Hocking County, Falls Township: Northern Ordnance 1, Roy B. Funk, Sec. 20, Clinton 2,490-2,521 ft., dry, TD 2,526 ft.

Muskingum County, Falls Township: Wittmer 1 H. Vandenbard, first quarter, Clinton 3,559-98 ft., dry, TD 4,832 ft.

EASTERN KENTUCY

ASHLAND. — Operations displayed a slight increase in eastern Kentucky this week but completions slumped with only two gas wells being reported. However, a study of reports reveals that a number of other wells are approaching what should be completion levels.

WESTERN KENTUCKY

OWENSBORO. — The Uniontown pool in Union County was extended ¾ mile south by Ashland Oil & Refining Co. and Basin Drilling Co. 1 Nolen-Alvey Community, which started at 342 bbl. per day on the pump without a shot. Pay was in Cypress sand at 2,275-87 ft., total depth.

The deepest test drilling in western Kentucky is Carter Oil Co. 1 Vaught, in 20-J-31, 3 miles northwest of Rochester, which is presumed to be a St. Peter sand test, expected to lie at about 5,500 ft. in depth. It is shut down at 3,681 ft. for repairs to the rig. Top of the Devonian was found at 3,405 ft.

In Daviess County, Miller & Shiarella and Ashland Oil & Refining Co. 1 C. R. Simmons, in 20-O-27, a mile east of West Louisville, had Aux Vases sand at 1,835-67 ft. and looked like a 15-bbl. well on a preliminary production test.

WESTERN KENTUCKY WILDCAT COMPLETIONS

Union County: Ashland and Basin Drlg. 1 Nolen-Alvey Community, NW SE NW 21-P-19, Cypress sand 2,275-87 ft., TD 2,287 ft. Pumped 342 bbl. in 24 hours. No. shot. Extends Uniontown pool ¾ mi. south.

Webster County: H. C. Hageman 1 Carl Curry, SE NE 3-L-21, dry at 2,470 ft., Glen Dean 2,152 ft., Barlow 2,417-24 ft., Cypress 2,434-63 ft. Location 3½ mi. NE of Clay.

INDIANA

EVANSVILLE.—A 41-bbl. McClosky lime well opened a new productive spot in Knox County. It was W. P. Muller 1 McDowell in 36-2n-11w. It also brought up 46 bbl. of salt water in its initial production test.

Superior Oil Co. completed a 205-bbl. well, 1 Armstrong, in 19-2s-11w, Gibson County, in Benoist sand at 2,112-22 ft. and McClosky lime at 2,305-07 ft., and the same company's 1 Flora Clark unit in SE NE SW 30-2s-11w, Gibson County, flowed 375 bbl. naturally from McClosky lime at 2,308-14 ft.

INDIANA WILDCAT COMPLETIONS

Knox County: William P. Muller 1 B. McDowell, SE NW SE 36-2n-11w, McClosky lime at 1,857-65 ft., TD, acidized, pumped 41 bbl. of oil and 46 bbl. salt water in 24 hours.

LOUISIANA GULF

New Sand Opened In Rosedale Field

NEW ORLEANS.—The Bully Camp field, LaFourche Parish, has promise of receiving its first oil production with favorable showings logged in Gulf Oil Corp. 6 Delta Securities Co., Inc., in 36-18s-20e. With the hole bottomed at 7,091 ft., an electrical survey showed oil sand at 6,396 to 6,437 ft., and 6,482 to 6,610 ft.

A new sand was opened in the Rosedale field, Iberville Parish, with the completion of Sugarfield 1 Leo Raw, completed through perforated casing at 10,134-38 ft., for an initial production of 173 bbl. daily through a ⅛-in. choke.

Gas-distillate production is believed to have been established 1 mile south of Krotz Springs, St. Landry Parish, with the showing of The Texas Co. 1 C. H. Swift. Bottomed at 10,648 ft., with 7-in. casing at 10,575 ft., a 2-hour drill-stem test in open hole from 10,575 to 10,648 ft., showed an unestimated amount of gas and a slight amount of distillate.

Union Sulphur 1 Lognion, which opens the first important oil production on the northwest flank of the South Roanoke field, Jefferson Davis Parish, was officially completed for an initial production of 216 bbl. of 42.5-gravity oil daily flowing through a 12/64-in. choke.

LOUISIANA GULF COAST WILDCAT COMPLETIONS

Beauregard Parish: Magnolia 1 Lutcher

Moore Lbr. Co., 22-6s-11w, dry at 12,325 ft.

Jefferson Parish: Texas 1 E. P. Brody, 65-16s-24e, dry at 10,985 ft.

CANADIAN FIELDS

Exploration Spreads Near Montana-Canadian Line

CHATHAM, Ont.—In southern Alberta, British Dominion Oil & Development Corp. and Imperial Oil will develop 25,000 acres in the Taber field on a 50-50 basis, about 6 miles east of Mid-Continent 3 and 7 miles southeast of the Dominion Oil producers.

Encouragement for a further northwest extension of Turner Valley is given by two British Dominion tests. British Dominion 6, LSD 6, 17-21-3w5, got the Madison at 7,910 ft. and British Dominion 7 at 8,150 ft. compared with 8,169 ft. in No. 5, the outpost producer. No. 7 is north and No. 6 east of the producer.

Pinhorn dome.—On Pinhorn dome, close to the Alberta-Montana boundary, McColl-Frontenac Oil 2, LSD 3, 17-8-1w4, is rigging up immediately north of No. 1 which is plugging back from 4,420 to 3,278 ft. to finish as a gasser.

Border wildcats.—Dominion Oils is continuing its program of two simultaneous wildcat tests in southern plains areas. Rig from Foremost 1, LSD 1, 14-5-12w4, is being used for Dominion-Conrad 1, LSD 8, 11-5-15w4, west of the old Skiff field. Dominion-Grassy Lake 1, LSD 3, 15-9-13w4, drilled to 3,275 ft., was abandoned and rig is being moved for Dominion-Legend in LSD 2, 15-7-13w4. Imperial Oil is moving equipment for Imperial-Grassy Lake 2, LSD 16, 6-10-13w4, and Imperial-Armelgra 2, LSD 1, 23-13-14w4.

Nova Scotia.—In the province of Nova Scotia, drilling equipment has been brought in by the Lion Oil Refining Co. of Arkansas for a test in the Mabou district of Cape Breton.

Gaspe.—In the Gaspe Peninsula of Quebec, Continental Petroleums, Ltd., 2 is below 1,810 ft., and nearing the horizon at which the Petroleum Oil Trust 20, to which it is an offset, encountered oil more than 40 years ago.

LA.-ARK.

Wildcat Activity Picks Up

MAGNOLIA, Ark.—There are now nine active wildcat tests in Arkansas, as a result of three new starts this week, one each in Lincoln, Nevada and Pope counties. There were no wildcat completions, but in Miller County, Jennings & Stueber 1 Offenhouser in 31-16-26 was reported preparing for a drill-stem test at 3,807 ft.

WILDCAT COMPLETIONS AND DISCOVERIES

	Week ended April 8, 1944					Cumulative total, 1944				
	Oil	Dist.	Gas	Dry	Tot.	Oil	Dist.	Gas	Dry	Tot.
Ohio	0	0	0	3	3	0	0	6	17	23
Indiana	1	0	0	0	1	1	0	0	3	4
Kentucky	1	0	0	1	2	3	0	0	15	18
Illinois	0	0	0	2	2	6	0	0	71	77
Michigan	0	0	0	7	7	4	0	0	58	62
Kansas	0	0	0	8	8	16	0	2	108	*126
Nebraska-Missouri-Iowa	0	0	0	0	0	1	0	0	6	7
Oklahoma	2	0	0	4	6	13	0	6	57	76
Texas:										
North Central	3	0	0	9	12	11	0	0	69	80
West	2	0	0	3	5	8	0	0	36	44
Panhandle	0	0	0	0	0	0	0	0	2	2
East	0	0	0	2	2	2	0	0	36	38
Gulf Coast	0	0	0	2	2	15	4	3	54	76
Southwest	0	0	1	5	6	11	3	7	63	84
Total	5	0	1	21	27	47	7	10	260	324
Louisiana:										
North	0	0	0	3	3	2	0	0	16	18
Gulf Coast	0	0	0	2	2	2	4	0	18	24
Total	0	0	0	5	5	4	4	0	34	42
Arkansas	0	0	0	0	0	2	0	0	15	17
Mississippi-Southeast	0	0	0	1	1	3	0	0	23	26
Montana	0	0	0	0	0	1	0	0	2	3
Wyoming	0	0	0	0	0	4	0	0	6	10
Colorado-Utah-Arizona	0	0	0	0	0	1	0	0	4	5
New Mexico	0	0	0	0	0	0	0	0	18	18
California	0	0	0	5	5	3	0	4	36	43
Total United States	9	0	1	57	67	109	11	28	733	881
Total previous week	8	1	3	49	*61					

*Revised.

Northeast Kansas Tests Fail to Find Production

ST. JOSEPH, Mo.—Ohio Oil Co. has announced two dry holes in Northeast Kansas. Its 1 Lamporter, 1½ miles west of Sabetha in C NE SW 3-2s-14e, Nemaha County, was dry at total depth of 3,947 ft. in the pre-Cambrian formation. Elevation was 1,326 ft. The Hunton was topped at 2,826 ft. There were some oil shows, which were tested after the hole was drilled to the 3,300-ft. level and plugged back. Several perforations failed to establish production. The hole was drilled deeper, Viola lime being topped at 3,581 ft., the St. Peter sand at 3,858 ft. and the pre-Cambrian at 2,938 ft.

Ohio 1 I. L. Peck in SE SE SE 15-1s-16e, Brown County, Kansas, 7 miles south of Falls City, Neb., was a dry hole at total depth of 2,880 ft. Elevation was 1,091 ft. The Mississippi lime was topped at 2,377 ft. and the Hunton at 2,780 ft.

Charles Miller et al 1 K. Schwarger in C N½ NW SE 21-9s-21e, Leavenworth County, Kansas, set 8-in. pipe at 670 ft. and had a hole full of water at 700-10 ft. The 8-in. was being underreamed at total depth of 710 ft. Alexander et al 1 Milliken in C W½ NW SE 10-12s-17e, Shawnee County, Kansas, was a new location.

In Holt County, Missouri, about 5 miles east of Oregon, F. C. (Bob) Miller and Harry Harper spudded 1 Eggar in C NE SW 32-60n-37w, and were drilling below 1,300 ft. This is their second test in their Holt County block, the first being a dry hole.

Cities Service Oil Co. 1 Watkins in C NE SW NW 32-65n-39w, Atchison County, Missouri, in the Tarkio oil pool, had the Bartlesville sand at 1,398 ft., but casing was stuck when the contractor tried to run the oil string.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, General Land Office, District Land Office, Las Cruces, New Mexico. Notice is hereby given that the lands herein described within the known geologic structures of the Pecos Valley and Red Lake oil and gas fields, New Mexico, are offered to qualified bidders of the highest cash amounts offered per acre as a bonus for the privilege of leasing the land under section 17 of the leasing act, as amended by the act of August 21, 1935 (49 Stat. 675, 30 U.S.C. 226), at a sale to be held in the District Land Office at Las Cruces, New Mexico, at 10 a.m., on May 18, 1944, in the following parcels, all in T. 17 S., R. 28 E.: Pecos Valley Field, Parcel No. 1, lots 1, 2, 3, 4, S½ N½, E½ SE¼ Sec. 3, E½NE¼ Sec. 10. Parcel No. 2, W½W½ Sec. 5 Red Lake Field, Parcel No. 3, SW¼SW¼ Sec. 10. Parcel No. 4, NE¼ Sec. 15. Each successfu bidder must deposit on the date of sale with the officer in charge of the sale a certified check or cash for one-fifth of the amount bid by him, and file the showing of qualifications to receive a lease, required by section 7 of Circular 1386. The remainder of the bonus bid and the annual rental at the rate of one dollar per acre must be paid and a $5,000 corporate surety bond must be furnished prior to the issuance of the lease. Each parcel will be offered for sale separately, but the successful bidder of the two parcels in either field may consolidate the two parcels in a single lease and may file a collective bond. Bids may be submitted by mail provided they are accompanied by one-fifth of the bonus bid and a showing of qualifications of the bidder. The envelope should be plainly marked for opening on the day and hour of the sale. Bidders are warned against violation of section 50, U. S. Criminal Code, approved March 4, 1909, prohibiting unlawful combination or intimidation of bidders. The right is reserved to reject any and all bids in the discretion of the Secretary of the Interior. Paul A. Roach, Register.

Butch was a good driller but strictly on the superstitious side. He used a pet Chinese rabbit's foot to keep his holes clean only the last time it didn't work on account of it was a Chinese holiday and a packer got all tore up and stuck. The Boss was superstitious about packers—or maybe it was a formation tester—getting stuck and fired Butch and ordered a Baker Rotary CASING Scraper which does the work a lot better than a rabbit's foot. For cement sheaths, burrs from gun-shot holes, and paraffine—the Scraper gets 'em all.

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REED ROLLER BIT CO., HOUSTON, TEXAS

Among the
Drilling Contractors

Rocky Mountain Drilling Co. is making good progress on the Frew lease of Standard Oil Co. of California at the west end of Aliso Canyon field, California. The terrain in this area is rugged and rough. Elevation of the well is 2,804 ft. above sea level and road building presented a real problem. The company recently landed 471 ft. of 4¾-in. liner at 9,290 ft. preparatory to completion in the Sesnon zone of Miocene age.

Two States Drilling Co., Houston, has apparently uncovered a new field in Matagorda County, Texas, 1½ miles south of El Maton, with the showing of Ohio-Continental 1 Heffelfinger. Drill-stem testing at 8,835-40 ft., recovered pipe-line oil and the well is coring ahead below 8,910 ft.

K. L. Kellogg, California drilling contractor, has rig up for a new well to be drilled for Western Gulf Oil Co. in the Oak Canyon field on the L. W. Gilmour lease.

Housh & Thompson, Houston, have cored the pay in Northern Ordnance, Inc. 1 Ammann, located in the Nada area, Colorado County, Texas, and casing is to be cemented for testing. Another rotary is active in the area for the same company.

Gus Pongratz, drilling contractor, recently completed a producing well in the Torrance, Calif., field for St. Francisco Oil Co.

Shamrock Drilling Co., headed by George McCarthy and J. J. O'Brien, which recently completed two wells at Arroyo Grande and one at Shiells Canyon for Los Nietos Co., will undertake another well for the same operator at Arroyo Grande in Santa Barbara County, California.

O. L. Riley, drilling contractor, is rigging up a new well to be drilled for Richfield Oil Corp. on the Los Flores property near Los Alamos in Santa Barbara County, California.

Fain Drilling Co., Houston, has successfully completed Continental Oil Co. 1 Heard to open a new Wilcox sand discovery in Goliad County, Texas. With the hole bottomed at 9,003 ft., production is from sand at 8,400 ft. Two other rotaries are running in the same county for Continental and Stanolind Oil & Gas Co., while additional development is being done in the Willamar and Lake Creek fields.

Baldridge & King have established a new gas-distillate field in Hidalgo County in Southwest Texas with their 1 Richard King, flowing gas and distillate through perforations at 6,900 ft. The well is located 3 miles south of Aurora.

Fox & Foley, drilling contractors, who are drilling the wildcat of Manufacturers Light & Heat Co. on the J. G. Hockenberry farm in Butler County, Pennsylvania, had cased the hole below the Medina to 6,691 ft. with 7-in. casing and had resumed drilling. The Trenton is the objective. This will be the first test to that horizon in southwest Pennsylvania.

Sprocher & Clark have been awarded a drilling contract by Mackinnie Oil & Drilling Co. for a test in a fault block at the south end of the Garland structure in Big Horn County, Wyoming. The location is approximately 7 miles southeast of the General Petroleum Corp. and Ohio-Kin-

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Houston, Texas. Phone: Preston 9783

ney-Coastal Tensleep wells on the Garland dome.

Loffland Brothers Drilling Co. has been awarded drilling contract on the Sinclair Prairie Oil Co. 1 Theimer, in NE SE SW 20-10n-3w, in the West Moore field, Cleveland County, Oklahoma, north of the discovery.

J. W. Frazier, Houston, opened a new Wilcox sand discovery in Goliad County, Texas, with 1 Chilton, located 2½ miles south of Weesatche. The well was drilled jointly with H. H. Coffield and R. N. Ranger, and is flowing gas-distillate from sand below 7,900 ft.

Brewster-Bartle Drilling Co., Houston, abandoned Skelly Oil Co. deep test in the Manvel field, Brazoria County, Texas. Other operations are reported in the Markham and Francitas fields while in San Jacinto and Bee counties three wildcats are being drilled for Sun Oil Co. and Navarro Oil Co.

Contractors Needing Trucks Should File Application

The American Association of Oilwell Drilling Contractors has advised its members by bulletin that the Office of Defense Transportation now has a petroleum branch in Washington, which is working closely with PAW toward allotment of as many trucks as possible to the petroleum industry. Any operator in need of a truck should file his application with the local ODT office in his district. If denied the right to purchase a truck he may file an appeal immediately for action by the Washington ODT office. In acting on these appeals the ODT consults PAW before reaching a decision. A movement now is on foot to manufacture an increased number of trucks in 1944, and it is possible that more than the 88,000 now planned will be built.

Appalachian Contractors Select Directors

R. M. Dinges, head of the material division for District 1, of Petroleum Administration for War, was the principal speaker at the recent annual dinner meeting of the Appalachian Drilling Contractors Association, at Bradford, Pa. He discussed recent changes in Preference Rating P-98b, and assured his hearers that PAW is now striving to the utmost to secure materials for the petroleum industry which are still difficult to obtain.

Following the dinner, the following were chosen members of the board of directors: Albert Cleveland, Smethport, Pa.; Jack Williams, H. B. Kenemuth and Paul Kahle, Duke Center, Pa.; Milton Titus, I. H. Sporer and J. Flanigan, Bradford; Milford Loop, Eldred, Pa.; Lee Harder, Wellsville, N. Y.; Norman Grosch, Clarendon, Pa.; L. R. Oakes, Mount Jewett, Pa.; Morris McKenzie, Rixford, Pa., and O. S. Blackman, Allentown, N. Y.

A.A.O.D.C. Seeks Place on Industry's War Council

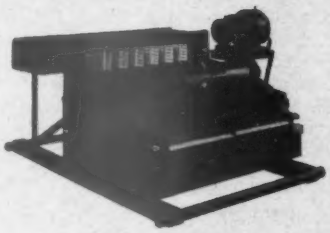
At a recent meeting of the board of directors of the American Association of Oilwell Drilling Contractors, in Dallas, the following definite recommendations were made:

1. That the board recommend to members of the drilling industry that they immediately file replacement schedules with the state selective service headquarters so that the industry can develop facts and information for use in their discussions with the War Manpower Commission and the national selective service headquarters on draft deferments.

2. That the Petroleum Administration for War be advised further of the acute need for oil-field trucks, and that all possible aid be given in obtaining a fair share of trucks allotted during 1944.

3. That steps be taken to have the president of the association represent the oil-well drilling industry on the Petroleum Industry War Council.

McNEELY
VIBRATING
MUD SCREEN



Handles the output from 20" mud pumps after surface hole is drilled. Average capacity 650 gallons per minute. Completely unitized. Screening surface—16 square feet. Domestic shipping weight less drive—1600 pounds. Headroom—27 inches. See Composite Catalog or write for details.

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McNEELY MATERIALS CO.
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No Other Leak Preventer Will Do

RECTORSEAL is made especially for the oil industry, by men who know oil industry problems, to put an end to all costly gas, steam, water, oil and mud line leakage.

It can be applied in a hurry, seals instantly, and breaks out easily due to its natural lubricating quality.

RECTORSEAL is insoluble in all petroleum products, is not affected by salt water or dilute acids or steam up to 400 degrees F.

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THE POSITIVE LEAK PREVENTER

The All Purpose Jack

Simplex No. 310-A, 15-tons capacity; 22" high, 14" lift.

Simplex Emergency Jacks are real manpower savers. The No. 310-A safely lifts, lowers, pushes or supports 15-tons. Lifts on cap, toe, auxiliary shoe or on chain which engages in cap. Ask for Bulletin "Oil-42."

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Better, Safer Oil Field Jacks Since 1899

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Make Your Jacks Last Longer! Send for free bulletin on the proper lubrication, care and handling of jacks.

PERSONALS

Had Little Time for Extracurricular Activities

W L. JARVIS, new chairman of the Pacific Coast district of American Petroleum Institute, Production Division, stepped into the oil industry as a geological draftsman in 1926, while he was attending the petroleum engineering division, College of Mining, University of California. For 2 years he kept up this exacting work schedule, and he was on a well crew with Humble Oil & Refining Co. for 6 months too, so he didn't have much time for extracurricular activities.

Shortly after his graduation from the university Jarvis got a job as scout for The Texas Co., with headquarters in Santa Barbara. Later he was transferred to Los Angeles and made chief scout for all of California. He held that post till the fall of 1938, and along with his scouting he did leasing work for the company. Then he was moved to the engineering office, and now is serving as development engineer.

Jarvis has been active for years in committee work for the A.P.I.'s Division of Production.

Julian Garrett, general manager of Northwestern Utilities, Ltd., of Edmonton, Alta., has been elected president of Association of Professional Engineers of Alberta.

Frank L. Fournier, division geologist for Imperial Oil, Ltd., at Calgary, Alberta, visited Tulsa and other Mid-Continent points following the annual meeting of American Association of Petroleum Geologists in Dallas. Fournier was employed as a petroleum geologist in Egypt, South America and the Far East previous to his present assignment in Western Canada.

Carl Hoot, a member of the Journal editorial staff for the past 6 years, was inducted into the U. S. Navy last week. For 3 years he had been in charge of the Journal's Kansas and Oklahoma field reports. He was assigned to the Pacific Coast for boot training.

Wilbur G. Perriguey, formerly technical consultant to the fuel and lubricants section of the Ordnance Department in Washington, has joined the engineering division of Standard Oil Co. of New Jersey as automotive fleet engineer in the fuels and lubricants section. His office will be at 26 Broadway.

Delmar C. Harman, superintendent of operations for Stanolind Oil & Gas Co. in the general office at Tulsa, resigned that post to become general superintendent for Glenn H. McCarthy, independent operator of Houston. Harman, who had been in the service of Stanolind 23 years, left for Houston last week to assume his new position.

STEWART P. KENT

Stewart P. Kent, since last summer acting division engineer for The Texas Co. in Tulsa, was appointed assistant district superintendent of the Illinois district last week. He succeeds **A. J. Holland,** who recently resigned. Kent, a Louisiana State University graduate, joined The Texas Co. 10 years ago and for 5 years served as petroleum engineer in Illinois. **Arch W. Baucum,** formerly assistant division engineer in the South Texas area, will replace Kent in Tulsa. Baucum, who graduated from Texas A. and M. College, started with the company 10 years ago as a roustabout.

F. H. Skehan, vice president and director of Colonial Beacon Oil Co., was elected president of Sylvestre Oil Co. at its annual meeting in New York. **George Holton,** general manager of the company, was elected a vice president. **Arnold Smith,** assistant general manager of Sylvestre, was elected a director of the company.

Roy S. Bonsib, New York, safety director of Standard Oil Co. (New Jersey), was the featured speaker at the recent petroleum section meeting of National Safety Council in New York. He drew special attention to the number of off-the-job accidents, pointing out that more than 50 per cent of last year's accidental deaths of workers fell in that category.

Lt. Comdr. Edward C. Lawson, in civilian life an independent oil producer of Tulsa, has been appointed to the Army-Navy Joint Petroleum Board in Washington. Since June 1942 Commander Lawson has been in charge of the Office of Naval Officer Procurement in Oklahoma City. In his new post, described as preliminary to foreign service, he will be a member of the highest agency handling Army and Navy oil problems.

Roy R. Morse, formerly manager of the exploration department in the Texas-Gulf area for Shell Oil Co., Inc., has been promoted to area manager. Morse, who entered Shell service as a geologist at Los Angeles in 1925, graduated in mining engineering and geology from University of California in 1913 and later received his Ph.D. there.

Daniel P. Murphy, whose foreign-service record includes development work for British Controlled Oilfields, Ltd., in Venezuela, and for Tropical Oil Co. in Colombia, left California by plane recently, accompanied by Mrs. Murphy, to resume his duties with the exploration department of International Petroleum Co., Ltd., in western Ecuador.

John R. Parker resigned as landman for Gulf Refining Co. at Evansville, Ind., to join Kingwood Oil Co.'s

land department in the Permian basin area.

John Henry Lewin has resigned as first assistant to the head of the anti-trust division of the Department of Justice to become a member of the legal firm of Venable, Baetjer & Howard of Baltimore. Lewin was prominent in the prosecution of the Madison trial and also the Government's case leading up to the consent decree involving pipe-line companies.

H. C. Creath, employed by The Texas Co. (Venezuela), Ltd., left Los Angeles by plane recently for South America. He was formerly employed in drilling operations for Colombian Petroleum Co. on the Barco Concession in Colombia.

W. F. Rhodehamel, merchandise manager and lubrication engineer of Seaside Oil Co., has been given additional duties and will head the company's asphalt and road oil sales department.

Ens. F. B. Loomis, Jr., formerly field geologist for Shell Oil Co., Inc., in the Shreveport district of Louisiana, has been made assistant operations officer at the Houma, La., blimp base.

D. B. Donlen, of The Texas Co., Chicago, has accepted the chairmanship of the asphalt subcommittee of the distribution and marketing committee of District 2, Petroleum Administration for War. He succeeds **E. W. Miles,** who resigned as chairman but will remain a member of the subcommittee.

Harold L. Bretz, formerly in the Casper, Wyo., office of The Ohio Oil Co., has been appointed petroleum engineer at the Haynesville, La., office. He takes the place of **E. B. Wharton,** who was transferred to Wyoming. Bretz is a graduate of University of Wyoming, where he majored in petroleum engineering.

R. N. Wright, superintendent of operations in Venezuela for Drilling & Exploration Co., was in Los Angeles recently on business. Wright formerly served in South America for Caracas Petroleum Co. and later for Guarico Oilfields, Ltd., of Venezuela.

A. S. Debenham, a junior engineer in the West Texas area for Asiatic Petroleum Corp. until he joined the R.A.F. in 1939, has been awarded the Distinguished Flying Cross in London. Debenham, a squadron leader, "three times brought his aircraft and crew out of peril when in difficulties over enemy territory."

Hal Marsh, General Petroleum Corp., with offices at the company's Vernon, Calif., headquarters, has been named national chairman of the American Petroleum Institute committee on standardization of pumping equipment.

Horace W. Hindry, who has been on Canadian assignment for Shell Oil Co., Inc., as a field engineer, has been appointed division foreman, construction and maintenance, San Joaquin Valley, California, district, and will maintain offices at Bakersfield.

R. O. Frame has been appointed superintendent of the Southwest Texas division of the Humble Oil & Refining Co. at Corpus Christi. Frame replaces A. O. Behling, who died recently in Corpus Christi.

Hiram Norcross, manager of Shell Development Co.'s New York office, and **A. J. Johnson,** head of the engineering department, have been made vice presidents of the company. Norcross, joining Shell Oil Co., Inc., in 1933, served first as a member of the legal staff in St. Louis. In 1941 he was transferred to the San Francisco office of Shell Development and a year later was assigned to his New York post. Johnson's headquarters will continue to be in San Francisco.

Gordon W. Reed, formerly president of Texas Gulf Producing Co., was made chairman of the board last week at the annual meeting in Houston, and **Lawrence S. Reed,** vice president, was elected president. **Val T. Billups** was reelected vice president. **William H. Hendrickson,** secretary-treasurer, was elected vice president and treasurer. **John M. Carter,** assistant secretary-treasurer, was chosen secretary and assistant treasurer.

Robert L. Cassingham, for years district geologist for Amerada Petroleum Corp. at Shawnee, Okla., has resigned that position to become an independent operator and consulting geologist in Shawnee. Amerada's district office has been moved to Tulsa.

William C. Brooks, for the past 4 years assistant to the president of Petroleum Equipment Co., Los Angeles, has been named special assistant to the director of materials in Petroleum Administration for War, in Washington. He succeeds **Alvin Zwerneman,** whose resignation became effective April 1. Brooks is in charge of the section responsible for allotments of controlled materials to the 400 or so petroleum equipment manufacturers who report to PAW as their claimant agency and industry division.

ORBIT VALVES

THE VALVES THAT CAN "TAKE IT"

Orbit Master Valve

ORBIT MASTER VALVE

The Orbit Master Valve is quick opening—has easy operation and a positive shut-off. A welded bonnet valve—insurance against possible gasket leaks.

YOUR ORBIT VALVES

will last for the duration. Meanwhile, if you have any questions regarding their care or maintenance, write us.

OIL WELL IMPROVEMENTS CO.

Since 1912

TULSA, OKLAHOMA

Market Developments

REGULATIONS were tightened this week on motor fuel in an effort to eliminate leaks through which liquefied petroleum gas and naphtha were reaching consumers. The more rigid regulations carried a dual connotation. First, the supplies of liquefied petroleum gas are under continual diminishment because of their position in the manufacture of 100-octane gasoline and synthetic rubber. New plants going on stream nearly every week at this stage of the construction program are pressing for additional quantities of butane, isopentane and other fractions in the liquefied petroleum gas range. Furthermore, enforcement officials are under pressure to block off the loopholes through which some car drivers are enjoying much greater freedom of movement than their neighbors. The drive to eliminate black-market trading which last week gained active support of the Petroleum Industry War Council stands a much better chance of proving effective if the leaks are plugged.

The enforcement activity recently resulted in charges against several Hollywood celebrities who had installed butane equipment in their automobiles. Numerous California automobile drivers had resorted to butane to circumvent gasoline rationing. The abuses of previous orders had become so widespread that drastic action was taken to stamp out the practice. The method of operation, according to California reports, was to retain some butane in tank trucks at points of discharge at Army camps and thereafter the fuel found its way into the black market.

Rural demand for gasoline in the Mid-Continent refining district, especially from the northwest, was pressing plant operators hard this week and much potential business is being rejected. Rains interfered with field work in agricultural communities, tending to relieve temporarily the acute demand for tractor fuels and gasoline.

A.P.I. Refinery Report

Week ended April 1, 1944

(Figures in thousands of barrels)

	Dly. crude runs to stills	Stocks: Gasoline	Stocks: Residual	Stocks: Gas oil
Appalachian	150	3,415	330	1,385
Ind., Ill., Ky.	759	20,788	2,801	4,871
Okla., Kans., Mo.	328	8,526	1,267	1,495
Censored area*	2,304	38,723	15,864	14,413
Rockies	109	2,218	576	383
California	785	15,492	30,488	7,883
Total 4- 1-44	4,435	89,162	51,326	30,530
Total 3-25-44	4,443	87,287	†51,669	†31,319
Total 4- 3-43	3,613	93,840	67,552	31,015

*Reports combined on East Coast, Texas Gulf Coast, Louisiana-Arkansas and Inland Texas at request of PAW. †Revised.

CRUDE-OIL STOCKS

(Bureau of Mines Estimate)

Week ended:	Bbl. of crude*
April 1, 1944	234,667,000
March 25, 1944	236,285,000
April 3, 1943	239,864,000

*Excludes unrefinable stocks in California.

CRUDE-OIL PRICES

Representative selected crude prices from all sections of the country appear below

East Texas	$1.28
Conroe	1.43
Tepetate, Louisiana	1.18
Illinois basin	1.37
Pecos County, Texas	.98
Bradford, Pennsylvania	3.00
Van, Van Zandt County, Texas*	1.09

*No change since 5-21-41.

Gravity Schedules

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill Calif.	Oklahoma, Kansas	Gulf Coast Texas	West Texas*
18-18.9	$0.80			
19-19.9	.84		$1.06	$0.70
20-20.9	.88	$0.85	1.08	.72
21-21.9	.92	.87	1.10	.74
22-22.9	.96	.89	1.12	.76
23-23.9	1.00	.91	1.14	.78
24-24.9	1.03	.93	1.16	.80
25-25.9	1.07	.95	1.18	.82
26-26.9	1.11	.97	1.20	.84
27-27.9	1.15	.99	1.22	.86
28-28.9	1.18	1.01	1.24	.88
29-29.9	1.20	1.03	1.26	.90
30-30.9	1.23	1.05	1.28	.92
31-31.9	..	1.07	1.30	.94
32-32.9	..	1.09	1.32	.96
33-33.9	..	1.11	1.34	.98
34-34.9	..	1.13	1.36	1.00
35-35.9	..	1.15	1.38	1.02
36-36.9	..	1.17	1.40	1.04
37-37.9	..	1.19	1.42	1.06
38-38.9	..	1.21	1.44	1.08
39-39.9	..	1.23	1.46	1.10
40 and above	..	1.25	1.48	1.12

*Includes Lea County, New Mexico

REFINERY PRICE SUMMARY

(Prices as of April 11, 1944)

Quotations are f.o.b. plant in cars and in cents per gallon except where otherwise noted. They are exclusive of the federal excise taxes of 1.5 cents a gallon on gasoline and 4.5 cents a gallon on lubricating oils, and do not include marine lighterage charges.

REFINERY GASOLINE

Octane (A.S.T.M.):	80†	72-74	68-70	63-65
Mid-Continent*	†6.00-6.25	5.750-6.000	.....	5.625
Gulf Coast	6.00-6.50	§5.750-6.250	§5.750-6.250	§5.250-5.750
Northeast Coast	9.50	9.2	9.2	.....
California	.....	6.255-6.500	5.750-6.125	5.125-5.500

*Basis Group 3. †1939 C.F.R. (research method). ‡Inland Texas and adjoining counties in Arkansas and North Louisiana. §Unleaded.

KEROSENE AND DISTILLATE FUEL OIL

Product:	Kerosene†	No. 2	No. 3	No. 5	No. 6‡
Mid-Continent*	4.125-4.375	3.500-3.625	3.375-3.500	$0.85	$0.80-1.27
North Louisiana*	4.125-4.375	3.500-3.625	.....	.....	0.80-1.27
Pennsylvania	6.000-6.125	5.875-6.125	5.875-6.000	.....	.....
California	4.500-5.500	5.500	5.500	§1.10-1.25	§1.10-1.15
Northeast Coast	6.800	6.700	6.700	1.95	1.95
Gulf Coast	4.125	3.750-3.875	.....	1.35	0.80

*Reflecting OPA ceilings, depending on destination of shipments. †Quotations for 41-43 gravity. ‡Range depends on gravity. §Pacific Specification 300. ¶Pacific Specification 400.

NATURAL GASOLINE

Grades:	26-70	18-55
Oklahoma (Group 3)	4.750	5.700
North Texas	4.375	5.250
North Louisiana	4.375	5.250
California	4.875	5.500

LUBRICANTS

PENNSYLVANIA GRADE—	
Bright stock,* 10 pour point	30.5
Bright stock,* 25 pour point	25.0
Steam refined, 600	15.0
Neutral oil,† 10 pour point	34.0
Neutral oil,† 25 pour point	28-32.5
*No. 8 color, 145-155 at 210, 540-550 flash. †150 vis. at 70° F., 3 color, 400-405 flash.	
MID-CONTINENT—	
Bright stock, 150-160 D, 0-10	23.00
Neutral oil,‡ 200-3	15.00
‡0 to 10 pour point	
GULF COAST—	
Pale oil, 200-3	8.75
Pale oil, 500-3½	10.00

WAX

Oklahoma, 124-126, w.c.s.	4.250
Pennsylvania, 122-124, w.c.s.	4.250
NEW YORK (in bags)—	
Refined, 130-132 (A.m.p.)	7.00
Crude, 124-126 (W.s.)	6.00

TANK-WAGON PRICES

(Gasoline prices based on regular grades in cents per gallon.)

	Dealer tank wag.	Combined tax	Kero tank wag
Baltimore, Md.	15.95	5.5	10.5
New York	16.10	5.5	10.1
Philadelphia	16.20	5.5	11.0
Washington, D. C.	15.20	4.5	11.5
Chicago	14.10	4.5	10.0
Cleveland, Ohio	14.50	5.5	*9.0
Atlanta, Ga.	18.90	7.5	*11.5
Denver, Colo.	14.50	5.5	11.0
San Francisco	14.50	4.5	11.5
Tulsa	16.90	7.0	9.9

*Includes 1-cent state tax.

Equipment Progress

Merchrome Weldlined Valves Developed For Refineries

A hard-faced type refinery valve, known as the "Merchrome Weldlined" valve, has been introduced by Merco

Nordstrom Valve Co., Pittsburgh, Pa. All of the surfaces of the valve coming in contact with the line fluid are hard-faced, including, in addition to the surface of the plug and interior of the body, the throat of the valve and the plug opening.

The standard method of merchroming a lubricated plug valve has been to hard-face the plug and the interior of the body with a highly resistant alloy. After hard-facing, the surfaces are ground and the plug is then lapped into its body. Improved methods now permit application of hard-facing over the gasket seats on the flanges, the throat of the valve, counterbore and the plug opening. This, in effect, gives to the valve the same advantages as if it was made of stainless steel throughout, or some other type of costly alloy, with considerable economy by using carbon steel for the structural parts.

The coating of the flow passages is smoothly laid; in fact, the finished result is a valve with the interior practically as smooth as an uncoated casting. This has been accomplished by improved methods of laying on the coating, using the atomic hydrogen method of arc welding, where desirable.

This new line is identical in sizes, pressure ratings, over-all dimensions and types, with the standard Nordstrom cast carbon steel valves, and for the purpose of identification, will carry the suffix "W.L."

Barrett Division Names Kelly and Davis

The Barrett Division, Allied Chemical & Dye Corp., 40 Rector St., New York, announces that T. P. F. Kelly has taken over a new assignment—that of contacting with all corrosion engineers from coast to coast in the development of cathodic protection, used with modern protective coatings.

Charles T. Davis is a newly appointed protective-coatings representative of the company in the states of Texas, Louisiana, Mississippi, Alabama, Arkansas, Florida, and New Mexico.

Campbell Joins Talon as Division Sales Manager

Robert A. Campbell, of Shelby, Ohio, for nearly 15 years associated in the marketing end of the steel-tubing industry, has been appointed sales manager of the Steel Tube Division of Talon, Inc.

Campbell is making his home in Oil City, Pa., the Talon Steel Tube Division offices and plant are located. He comes from Ohio Seamless Tube Co. at Shelby where he had been assistant sales manager for the past 7 years. During the 3 years prior to that time, he was assistant sales manager of Standard Tube Co., Detroit, and for 5 years before then he was with Republic Steel Corp., Steel and Tube Division, Cleveland.

Along with the announcement of Campbell's connection with Talon, officials of the firm stated that work on the addition to the Oil City plant was rapidly going forward, and it is expected the project will be completed in 60 days.

Stanbery Joins Norris In Mid-Continent

R. B. Stanbery, who has had wide experience in the sales and service of subsurface equipment for the producing well, has been added to the staff of W. C. Norris, Manufacturer, Inc., Tulsa, and will serve the Mid-Continent area. Stanbery's first oil-field experience was with Frick and Lindsay in Pennsylvania in 1916. This firm later became Frick-Reid Supply Corp.

In 1927 Stanbery moved to California and entered the employ of Superior Oil Company of California. Additional experience was gained there with the D. and B. Division of Emsco Derrick & Equipment Co. In 1935 he moved to Dallas where he was connected with both Emsco and Continental Supply Co. at various times. His experience will be directed to the sucker-rod division of the firm.

Dickey Producing New Pipe For Salt-Water-Disposal Line

The W. S. Dickey Clay Manufacturing Co. is now producing an extra-strength, thicker-shell, acid-resisting clay pipe for salt-water-disposal lines and types of construction where additional strength is required.

Specifications provide for 100 per cent increased strength over double-strength pipe in sizes, 4, 6, and 8-in.

For salt-water-disposal lines the company suggests the use of a jointing compound known as Ampco which is a sulfur-base product. It is said to resist chemical action, insure tight joints and withstand heat temperatures encountered in such lines.

Elliott Joins Oil Center Tool Co. as Representative

Ace Elliott has joined Oil Center Tool Co., Houston, as representative of the company's sales department in Southwest Texas, with headquarters at Alice, according to an announcement by the company. Elliott has been identified with the oil industry in both drilling and production and equipment sales capacities for more than 16 years, and is well known in the Gulf Coast area.

Classified Advertising

The Market Place for the Oil Industry

UNDISPLAYED RATE

6 CENTS A WORD, minimum charge $2 per insertion.

SITUATIONS WANTED, 4 cents a word, minimum charge $1.

BOX NUMBERS, count 9 words when replies are to be sent to our Tulsa Office.

10% DISCOUNT if 3 insertions are ordered at one time, with check accompanying order.

All classified advertising payable in advance.

DISPLAYED—PER INCH

Classified display advertising set in single or double column style:

1 inch	1 time	$7.00
1 inch	13 times	6.50
1 inch	26 times	6.00
1 inch	39 times	5.50
1 inch	52 times	5.00

Rates are governed by total space used within 12 months from date of first insertion. Credits are allowed when lower rates are earned.

FORMS CLOSE 9:00 A.M. MONDAY
Published Each Thursday

LEASES AND DRILLING BLOCK

NEW MEXICO
STATE OIL AND GAS LEASES

Humble Oil & Refining Co., now drilling a scheduled 7,500 foot test. Other major oil companies own lease blocks near test. I offer 40 acres and multiples thereof in same area. Write for information. HARRY S. WRIGHT, New Mexico State Lessee. Farmington. New Mexico.

ATTENTION OIL OPERATORS: Would like to hear from those who can lease up and finance their own wells. Test well completed, write for information. Albert Rost, 22 W. Fairview Ave., Dayton 5, Ohio.

FOR SALE half interest in mineral rights from our own land where rig is now drilling, deep in Panola County. Now fast coming in hot spot. We can help with other, excellent opportunities, act quick. T. A. Greer Lumber Co., DeBerry, Texas.

NEWLY PROVEN OIL FIELD. Resembles Elk Basin, Wyoming. Seven known oil sands. Offering 160-acre lease, 87½%, $25 per acre. Drilling started on structural "nose." Cash to be placed in bank escrow for drilling purposes, payable only when well reaches producing sand. Depth approximately 3,000 ft. Pvt. Keith Morton, Gore Field, Great Falls, Montana.

LEASE for sale, shallow drilling in Texas. 3 pay stratas within a 2400 foot drilling Burger lime 720 feet. Fry Sand 1500. Cisco Lime 2340. All Carry oil production, owner financially unable to operate. For information and geological report write Box 5-D, Elks Club, 512 West 4th Street, Ft. Worth, Texas.

LEASES - ROYALTIES

PRODUCING OR NONPRODUCING
Texas, New Mexico, Oklahoma
Louisiana and Illinois.
Inquiries Invited.

B. D. BUCKLEY
40 Broadway Drive, Clayton
St. Louis, Mo.

LEASES AND DRILLING BLOCKS

WEST TEXAS — New, long term leases lowest price, cheapest rentals, large or small tracts. Do you have block anywhere you want drilled, OR do you want block to drill. Information and maps write: F. L. Welch, 1711 Roosevelt Ave., San Antonio Tex.

SOUTH Georgia leases and royalties bought on cash or interest basis. References furnished. C. W. Deming, Waycross, Ga. 20 years operating out of Tulsa.

FOR SALE: Oil and gas leases and small production, located in Southwestern Kentucky, near drilling and producing wells. W. P. Harley, Bowling Green, Ky.

WANTED TO BUY: 50 to 500 Barrels of production per day in Shallow Field, Kentucky or in Indiana. Box C-251, The Oil and Gas Journal, Tulsa, Okla.

ARKANSAS-Louisiana-Texas leases twenty acres up. Dollar acre up. Owners Box 1122, Little Rock, Arkansas.

FLORIDA OIL TRACTS for sale. Full mineral rights. $250 up. $50 down. $10 monthly. W. H. Perrins, 528 N.W. 10th Avenue, Miami 36, Florida.

BRYAN County, Oklahoma, Oil Leases: Royalties, 10 to 1000 acres. From Atlantic test South to Red River; Townships: 8-8, 8-9, 9-9. Box 415, Durant, Oklahoma.

FOR SALE: 80 acre lease near production, E. Texas, plenty of activity. $3 per acre. Write immediately. C. A. Parker, Box 451, Center, Texas.

DRILLING BLOCKS
EXCELLENT GEOLOGY

Block in New Mexico ready for drilling; near good production. Also good block in Oklahoma, possible extension Bartlesville producing field. Excellent supporting geology. Substantial parties' inquiry invited. Bank references exchanged. P. O. Box 1914, Fort Worth, Texas.

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REPRESSURING

Undertake repressuring, especially large propositions Kansas, Oklahoma, favorable for secondary recovery-percentage increase. New repressuring technique. Reliable engineers. Give map and details. Address Box C-277, The Oil and Gas Journal, Tulsa, Okla.

HAVE GAS RECYCLING PLANT EQUIPMENT

WANT GAS-DISTILLATE PRODUCTION

Large independent operator will move complete, new recycling plant to gas-distillate area having proven reserves and enough producing wells to justify immediate operation, or would consider drilling additional wells. Can handle gas at any high pressure. Give complete information first letter. P.O. Box 1914, Fort Worth, Texas.

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CAPITAL SEEKERS — Interested in raising $25,000 or more for a legitimate project should write to AMSTER LEONARD, Fox Theater Bldg., Detroit 1, Mich.

CAPITAL inexpensively raised. Write for our proposition today. No charge for consultation. Postcards ignored. Address: Service P.O. Box 165, Chicago 90, Ill.

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The Denver Basin, Colorado, large oil structure open for test, geology. Address Box C-278, The Oil and Gas Journal, Tulsa, Okla.

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Backing of Oil Minded and Monied people for leasing and preliminary work prior to drilling. Attractive areas and Structures in Rocky Mountain Region open for lease and Development. If you have funds for this field and want reliable people to handle, address Box C-274, The Oil and Gas Journal, Tulsa, Okla.

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Rough or completely machined
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DROP FORGING DIES

Prompt delivery on drop forging dies. All sizes up to 1½ tons. Largest die sinking plant in West. Write, wire or phone. National Aircraft Equipment Co., 275 No. Avenue 19, Los Angeles 31, California. CA 4111.

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WANTED: One (1) Propane Storage Tank capacity approximately 18,000 to 20,000 Gallons—or two (2) Propane Storage Tanks approximately 10,000 Gallons each W.P 220# hydrostatically tested 440#. ARROW PETROLEUM CO., Centralia, Illinois

ONE C-250 7¼" x 15" National Power Pump Good condition. LUCEY PRODUCTS CORPORATION, Tulsa, Okla.

WANTED to buy a Gas driven slush pump, size 4 x 10 or 3 x 10 without an engine. George F. Askin, c/o Milligan Hotel, Miles City, Montana.

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Unlimited quantity of
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EQUIPMENT FOR SALE

FOR SALE: Reconditioned cast iron and steel valves. Also large stock of fittings. APEX IRON & METAL COMPANY, 2204 South Laflin Street, Chicago 8, Illinois.

FOR SALE: 18—2" single and 4—2" double Standard McDonald type used swing joints $3.50 and $7.50 each, respectively. Cities Service Oil Company, Patridge, Bartlesville, Oklahoma.

FOR SALE: Lube-Oil Refinery, Santa Fe Springs, California, new plant, good condition, ideal reclaiming plant. Write C. C. Horton, 506 Richfield Bldg., Los Angeles 13, California.